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An Exact Basis of Proportioning

A Discussion of Proportioning Methods, Pointing Out Some Inaccuracies and Suggesting a Method That Overcomes Them—An Example Is Given

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CONCRETE mixtures are generally proportioned arbitrarily 1:1½:3, 1:2:3, 1:2:4, etc. Any one such mix may have excellent workability and quality producing characteristics one day and quite the contrary the next.

Aggregates for concrete mixtures are generally measured arbitrarily by loose-moist volume, sometimes by inundated volume and sometimes by weight. No one of these three methods of measurement, in fixed ratio, is exact or definite as a basis of proportioning, for the following reasons:

Aggregates from the same source vary widely from day to day in average diameter of particles, gradation of sizes of particles, moisture content, absorption, density, specific gravity, and bulking by loose measurement and moisture. The absolute* volumes and gradation of sizes of particles in a mix, the water required for workability and the cement required for the strength, or other properties of the concrete, are changed by these variations of the physical characteristics of the aggregates.

Effects of Variations in Aggregates

These variations in particular are as follows:

(a) Loose-moist measured volumes are affected by "bulking" or increase over the standard dry-rodded volumes. This bulking is due to looseness of measure, moisture content and diameter of particles and varies from about 0 per cent to 45 per cent. The absolute volume of particles in a given volumetric measures varies inversely with this bulking.

(b) Inundated volumes bulk from 0 to 8 per cent depending upon the average diameter of particles. The amount of water required for inundation varies from 15 to 50 per cent indicating the voids in and density of the material in the measure. The absolute volumes vary inversely with this bulking and directly with the density.

(c) The standard dry-rodded volume varies in density from about 50 to 90 per cent depending upon the shape, maximum size and gradation of sizes of particles, and the absolute volume in a given measure varies directly with this density.

(d) The absolute volumes, corresponding to particular weight measurements, vary inversely with the specific gravities and moisture contents of the aggregates.

The effects of these variations are sometimes accumulative in one direction or the other and the strength, density, impermeability and durability, of the resulting concrete, vary widely likewise.

Requirements of Exact Proportioning

It is obvious from the foregoing that arbitrary proportions, by any method of measurement, are wholly meaningless as an exact basis of mixture for uniform quality of concrete. It can also be seen that an exact basis of proportioning concrete mixtures must comprehend the absolute volume of aggregate particles. However, one absolute volume may contain particles all one size and others—two, three or an infinite number of sizes. To be alike, practically, they must have nearly the same gradation of sizes.

We find that strength, density, uniformity, impermeability, workability and economy of a concrete mixture depend largely upon the maximum size, coarseness and uniformity of grading of diameters of aggregate particles from fine to coarse; also, that silt (or other inert particles finer than the average cement particle) adulterates the cement and reduces the strength and density of the concrete. These requirements of maximum and minimum size, coarseness and uniformity of grading of aggregate particles are expressed by the Kitts-Peugh grading equation

$$r = \frac{1 - (d/D)^m}{1 - (A/D)^m}$$

in which (r) is the proportion by absolute volume retained on a given sieve opening of (d) inches, (D) is the maximum size of the aggregate, $(^m)$ is an exponent and (A) is the minimum size of the aggregate, excluding silt. We have, then, absolute volumes of particles, of any size limitations, uniformly proportioned to a definite coarseness of gradation of particles. To this we must add cement and water.

The strength, density, impermeability and economy of concrete depend also upon the absolute volume of cement to unit volume of concrete and upon the absolute volume of mixing water to unit volume of cement.

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*"Absolute volume," as used herein, denotes "apparent volume," as generally termed by concrete physicists, and is the volume within the surface of the particles.

An exact basis of a concrete mix, then, consists of:

(1) Aggregate particles having a maximum and minimum size limitation, uniformly graded to a particular coarseness by diameters and absolute volumes of particles;

(2) An absolute volume of cement to a unit volume of concrete; and

(3) An absolute volume of mixing water to a unit volume of cement.

Having given materials of standard quality, the aggregates being rounded particles, and, the requirements being a compressive strength of 3,000 lbs. per sq. in. at 28 days; the mix may be specified as follows:

Basis of Mix

Strength: 3,000 lbs. per sq. in. at age of 28 days.

Grading: $$r = \frac{1-(d/D)^m}{1-(A/D)^m}$$ in which

$m = 0.5$, $D = 1.5$ in., $A = 0.00146$ in.

Cement: Absolute volume per cubic yard of concrete = 3,395 cu. ft. = 1.75 bbl. (for density of cement 0.485).

Water: Water to cement ratio by absolute volume = 1.85.

Method of application:

The theoretical percentages of the mixed aggregate retained on and passing the standard screens are determined from the equation to be as follows:

Sieve No.	d''	100 r	100-100 r	
A	.00146	100	0	C. M. = 5.24
200	.0029	99	1	
100	.0059	97	3	
50	.0117	94	6	
30	.0234	90	10	
16	.0469	85	15	
8	.0937	77	23	
4	.187	67	(33)	C. M. = 9.23
⅜-in.	.375	52	48	
¾-in.	.75	30	70	
1½-in.	1.5	0	100	

Sum/100 = 7.91 = Coarseness Modulus

The summation of the proportions retained on each screen is a function of the average diameter of particles and may be called a "coarseness modulus," the larger the value, the coarser the material. It is of the same character as the well-known "fineness modulus." Its practical value is that by its use we are able to determine by an algebraic process the proportions of two, three or several sizes of aggregates so that their combination most nearly conforms in grading to the theoretical grading curve. The greater the number of sizes of aggregates, the more nearly we can approximate the theoretical grading by its use.

Let us assume that we have on the job two sands and two gravels whose characteristics are as follows:

Practical Size Limits	Coarseness Modulus	Loose-Moist Density	Specific Gravity	Moisture by Apparent Volume	Absorption by Apparent Volume
A-No. 16	3.84	.511	2.57	.174	.040
No. 100-No. 4	5.35	.585	2.62	.182	.026
No. 4-¾-in.	8.55	.585	2.66	.113	.020
¾-1½-in.	9.83	.581	2.65	.061	.020

We then separate the theoretical grading at the No. 4 sieve, corresponding to the pairs of job aggregates, and find the theoretical coarseness modulus of the sand to be 5.24 and that of the gravel, 9.23. The coarseness modulus of the combined aggregate is 7.91.

We have then by simple proportion:

$$100\,\frac{(9.23-7.91)}{(9.23-5.24)} = 33 \text{ per cent sand,}$$

$$100-33 = 67 \text{ per cent gravel, and}$$

the proportions of the job aggregates are

$$33\,\frac{(5.35-5.24)}{(5.35-3.84)} = 3 \text{ per cent fine sand,}$$

$$33-3 = 30 \text{ per cent coarse sand,}$$

$$67\,\frac{(9.83-9.23)}{(9.83-8.55)} = 31 \text{ per cent fine gravel,}$$

$$67-31 = 36 \text{ per cent coarse gravel,}$$

Total 100 per cent

These are the proportions of dry aggregate by absolute volume while the given coarseness moduli are prevailing.

The absolute volume of mixed aggegate in one cubic yard of concrete of the given specifications will be:

$$\frac{27}{\text{yield}} - \overset{\text{Cement}}{(3.395)} - \overset{\text{Water}}{(3.395 \times 1.85)} = 17.324 \text{ cu. ft.,}$$

assuming the yield as unity. We have then

		Absolute Volume, Cu. Ft.
Cement	1.75 × 4 × .485	= 3.395
Mixing water	1.85 × 3.395	= 6.281
Fine sand	17.324 × .03	= 0.520
Coarse sand	17.324 × .30	= 5.197
Fine gravel	17.324 × .31	= 5.370
Coarse gravel	17.324 × .36	= 6.237
Total		27.000

The correction for moisture content and absorption is 6.281 — .52 (.174 — .04) — 5.197 (.182 — .026) — 5.37 (.113 — .02 — 6.237 (.061 — .02) = 4.645 cu. ft. = 34.8 gals. to be added.

The proportions, measuring aggregates by loose-moist volume, are:

		Loose Volume
Cement	1.75 × 4	= 7.0 sacks
Added water		= 34.8 gals.
Fine sand	0.520/.511	= 1.0 cu. ft.
Coarse sand	5.197/.585	= 8.9 cu. ft.
Fine gravel	5.370/.585	= 9.2 cu. ft.
Coarse gravel	6.237/.581	= 10.7 cu. ft.

The proportions by weight are:

		Pounds
Cement	1.75 × 4 × 94	= 658
Added water	4.645 × 62.4	= 289
Fine sand	0.520 (2.57+.174) × 62.4	= 89
Coarse sand	5.197 (2.62+.182) × 62.4	= 909
Fine gravel	5.370 (2.66+.113) × 62.4	= 929
Coarse grvl.	6.237 (2.65+.061) × 62.4	= 1055

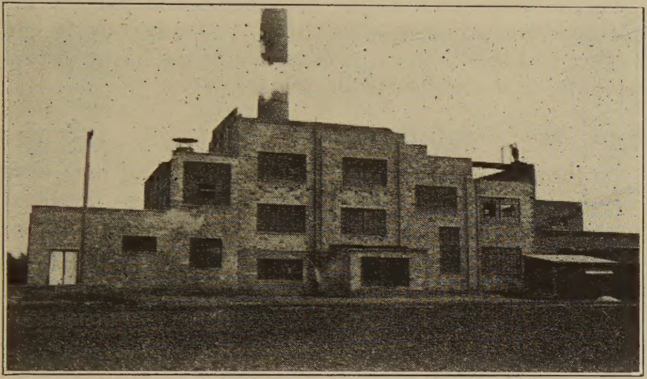
It should be kept in mind that the calculated proportions are correct only so long as the characteristics of the aggregates remain the same. One man-hour of systematized and co-ordinated laboratory control is required for every 10 to 50 cubic yards, depending upon the conditions, in order to keep up with the change of materials with the most economical results.

As the exact structure of the mix is maintained, the physical characteristics of the concrete, strength, density, weight, appearance, etc., are more uniform than possible to accomplish otherwise. Saving of the margin of excess cement usually allowed in lieu of exact proportioning, covers the cost of this manufacturing control on small, and many times over, on large projects; and the quality of the concrete is assured before placing.

"Spec" Collins Speaks His Mind

Has the Concrete Products Business Gone to the Bow-Wows? —Or Is It Due for a Greater Future?—A Veteran of the Industry Tells Us Exactly How It Looks to Him

JUDGING from innumerable conversations I have had of late with brother concrete products manufacturers, the business has gone to the demnition bow-wows. But I sometime wonder if it really has. Aren't we just in a period of transition? Aren't we just going through a period of uncertainty the same as any other business in the building material field? Changes have come fast and furiously in the past four years. The bright spot in this era of so-called profitless prosperity is the man who is adapting himself to these changing conditions and is looking into the future.



Buildings the size of this require aggressive merchandising to put across

What Is Happening?

Just what *is* happening? You can answer it for yourself. Take a flat container of some sort and step out to your aggregate pile. Fill it half full of aggregate and shake it gently for a few moments. Gradually the larger pebbles work their way up to the top. That's what's going on in the concrete products business. The manufacturers who are big enough to have a vision of the future and what it has in store for them are being shaken to the top. Their narrow-minded competitors who are thinking of today and today alone are gradually being worked to the bottom.

Don't get the wrong idea when I use the word "big." One of the biggest concrete products men I ever met, in my estimation, lived in a little cross-roads town off the railroad and had a plant that a good many of our so-called "big" manufacturers would stick up their noses at. Yet this man had such a good imagination, such a good sense of merchandising and so much perseverance that there was scarcely a soul within a twenty-five mile radius that hadn't heard of him and his products. If a barn burned down in his community nine chances out of ten it would be rebuilt of concrete block—and the contract would be signed while the embers still smouldered to remind the owner of the instability of any but fire-resistive construction. About the time this man really decided there was a future to the concrete products business the drive for more stucco-covered concrete block houses was started. This man cashed in, using to a great extent the literature furnished by the P. C. A. and sales helps from his state concrete products association. The first year he sold two houses, but the next year he trebled that and the year following built eight. This man was a "big" manufacturer because he was always looking forward, because he was taking advantage of the sales helps offered him and because he was constantly keeping abreast of the times

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A store, apartment, and recreation building foundation using some 16,000 concrete block

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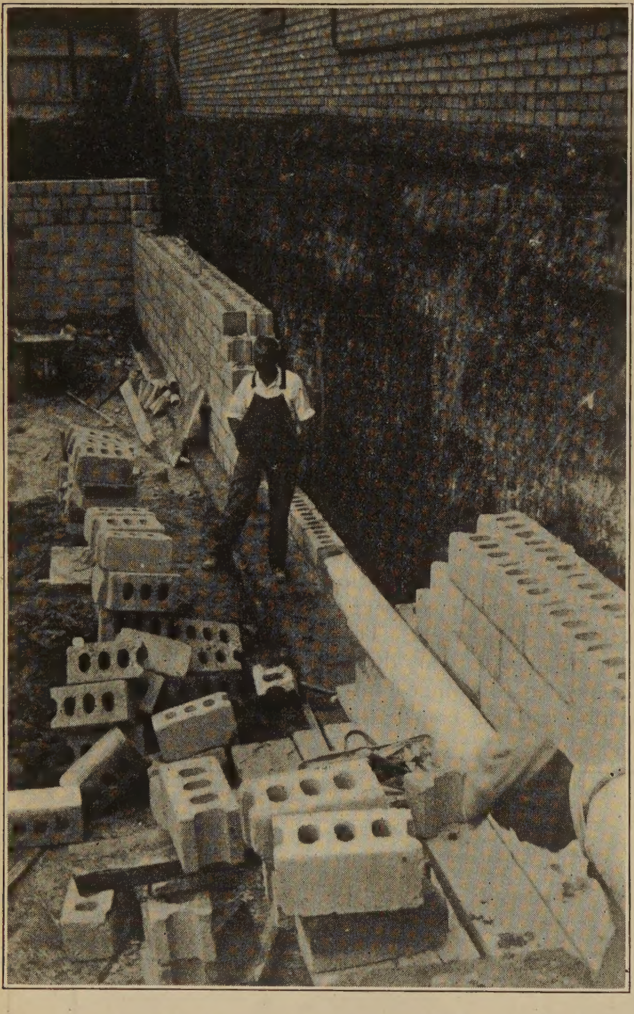
and looking into the future. The measuring stick of any firm's success can generally be determined in advance by their ability to adapt themselves to new and changing conditions.

A Changed Industry

We may as well make up our minds that the past few years have brought about a complete change in the concrete products business. We are living in a new world as far as our business is concerned. New light-weight aggregates have considerably broadened our field above grade. And because the units made of these aggregates are of the same size and shape of those made of the older and more familiar materials they have strengthened the confidence of the building public in these older materials.



Showing double 8-in. block used in 16-in. wall. A row of headers will cross the wall shown exposed

All of us cannot have access to these new materials. We must take what we have and develop it. In other words we must develop the *merchandising side* of our business as well as we have developed the manufacturing. Compare the production methods of even ten years ago with those of today. We've certainly made vast strides in the improvement of our product and the methods of making it. Then make a similar comparison of sales and advertising methods. You surely must be impressed with the fact that the sales and advertising scheme as a whole has not kept pace with production. And salesmanship is a vital factor today if production is to be kept at the point that will make it economical.

Develop Your Market

Take what you have and develop it. Find new uses. Get into a better class of construction. Concrete building units *were* primarily a basement material. That seemed to be the line of least sales resistance to many of us—and it still has great possibilities. It was not many years ago in this market when we rejoiced if we were able to put concrete blocks in the basement of a few of the larger homes of our so-called Gold Coast. Ninety-five per cent or even more of the basements of these high-class homes that are being built today have concrete block basement and partition walls. This change has not come about by sitting back and waiting for it to happen. It has been brought about by aggressive salesmanship on the part of concrete products manufacturers who knew they had a mighty good product suitable for this work and who weren't afraid to tell architects, builders and owners about it. Part of this was done by individuals and part by the local concrete products associations. At any rate it had its effect and the concrete products industry has a virtual monopoly on the basement business.

Bigger Basement Business

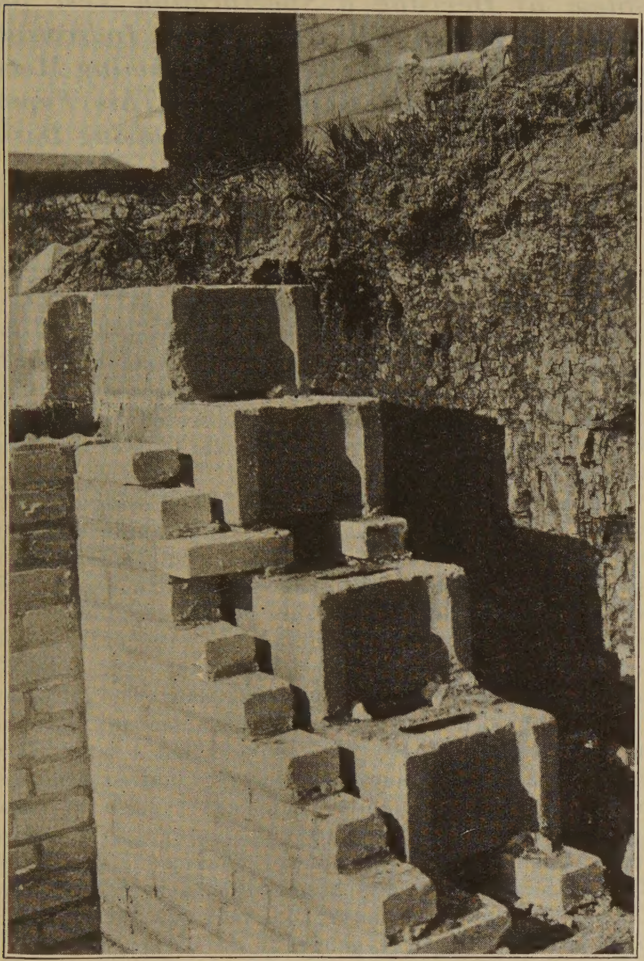
One thing seems to lead to another. Noting how easy it was to get this finer type of residence business the local manufacturers, strengthened again by their association, went after an even larger class of work. Keeping in the basement field, they went after and succeeded in bringing about a change in the type of construction used for store and apartment basements. This larger work has resulted in the development of several new types of construction and has given an outlet for a number of sizes of blocks that formerly were used very sparingly. In the majority of these larger basements a 16-in. wall is required by the state building code.

This is built in any one of three ways. The most common is that of using three courses of 8-in. block laid parallel, with the fourth course a header course, the block being placed crosswise to the wall. This construction of three courses of stretchers and a course of headers is continued until the height wanted is attained. The headers are usually made with two flush ends to facilitate back plastering on the outside and give a smooth wall on the inside. Another combination used to secure this 16-in. wall is that of using twelve-inch block lined with brick. The brick are bonded-in as shown in the accompanying illustration. The third combination is that of a 10-in. block and 5-in. hollow slab. The position of these units in the wall is usually reversed every other course. Where a 16-in. foundation is required for brick veneer buildings the top course is often of 12-in. block, leaving a 4-in. projection on which to start veneering.

These examples of what it is possible to do with the units that so many of us are now making are given to show the business that may be developed by aggressive merchandising on the part of the manufacturer. Much of this development work on larger foundations was done during the winter months when it was difficult for the average contractor to protect monolithic concrete from freezing. It not only resulted in good winter business for the concrete products manufacturer but has resulted in a good all-the-year-round business as well. It is what is meant by adapting ourselves to changing conditions. There has been an epidemic of apartment and combination store and apartment building in the outlying sections of this community during the past two years, but instead of lamenting the fact that every apartment building meant so many less homes with basement jobs we have put the material into the apartment jobs instead of the homes.

Snap Into It!

So the business is going to the dogs? Yes, it is for some of us unless we snap out of the lethargy we are now in. Most of the larger manufacturers are large because they have relied on the same things to sell their products that the larger plants in any line of business have depended on—intelligent merchandising methods.



Twelve-inch block and brick liner for 16-in. foundation

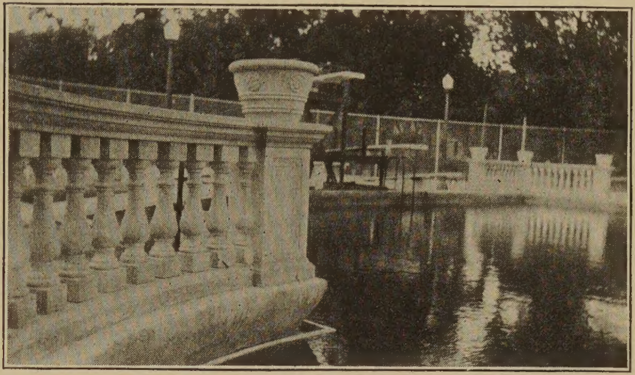
It almost passes belief that some concrete products manufacturers are as shortsighted as they seem to be. We are in an era of short profits and long competition. Truly it is a buyers' market, but we can all do our share in influencing the mind of the buyer. We must no longer take it for granted that we are doing the right thing in the right way. We must search, investigate, question, find out the methods of others and compare them with our own. We must do business in the new way or be left in the dust of the trails of our more progressive competitors.

Concrete Swimming Pool Is Popular

Early in June the city of Estherville, Ia., (5000 population) completed an 80- by 170-foot reinforced concrete municipal swimming pool in the city park. The structure is divided into three areas as indicated in the photograph: one, a deep section for diving; another a division for bathing; and a third area of shallow water for the use of the children. The diving section is approximately 9 ft. in depth while the bathing area varies from 3 to 4½ ft. and the children's portion of the pool has a maximum depth of 18 in.

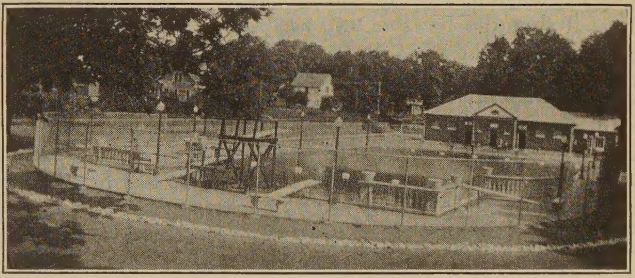
A concrete beach entirely surrounds the pool and an 8-ft. heavy wire fence keeps bathers from coming in contact with anything but clean concrete after they have left the showers and entered the pool.

The water in the pool is kept in a sanitary condition by modern equipment, the 300,000 gallons necessary to fill it being completely re-circulated, filtered and chlorinated once in every 18 hours. A scum gutter built in the walls at the water line carries off any debris which might get into the pool and materially assists in keeping the water clean and attractive.



It is almost impossible for a novice to get into trouble in this pool, as the deep water is clearly marked by ornamental concrete balustrades and protected in the water by a rope suspended on buoys at the point where the depth changes. In the bathing section and the part used for children the bottom of the pool slopes very gradually and the depths at various places are clearly marked on the side walls. During the entire time that the pool is in use a lifeguard is on duty to guard against possible accidents.

The capacity of the pool is set at 500 at a single time. On the Fourth of July a check showed 1,047 persons enjoyed the privileges afforded by this modern swimming pool. With the exception of Sundays and holidays children are admitted free from 10:00 to 12:00 A. M. Prices are 15 cents for children and 25 cents for adults if patrons furnish their own suits. A charge of 15 cents for children's suits and 20 cents for adults' is made to those who do not have their own bathing suits. Soap and a clean towel cost 5 cents.



The pool was designed and the construction supervised by the Howard R. Green Company, engineers, Cedar Rapids, Iowa. The contractor was the Milford Construction Company, Milford, Iowa. The pool was financed by municipal funds.

Meeting of Highway Research Board

Announcement is made by Roy W. Crum, director, that the eighth annual meeting of the Highway Research Board of the division of engineering of the National Research Council is to be held December 13th and 14th, 1928, at the building of the National Academy of Sciences and the National Research Council, Washington, D. C.

A Plastic Mortar Compression Test for Cement

The Problem of Devising a Specification Test for Portland Cement Which Will Give a True Indication of Concrete-making Qualities Is Ever Assuming More Importance. The Results Reported in This Paper Are Offered as Furnishing the Most Promising Basis Found So Far for a Solution of the Problem

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FOR the past two years the Central laboratory of the Lehigh Portland Cement Co. has maintained a continuous research program involving quality studies of cement. These studies have been based on very carefully controlled compression tests of concrete made from samples of cement taken at regular intervals at each of the company's plants. In addition to the concrete studies, other tests have been conducted concurrently on the same cement samples in an endeavor to find a test which would accurately indicate concrete-making quality. During the first twelve months of operation two types of indicator tests were studied: the standard Ottawa sand mortar tension test as prescribed in the A.S.T.M. Standard Specifications and Tests for Portland Cement (C 9—26) and compression tests of 2-in cubes of a fluid cement-water mixture proposed by D. A. Abrams.[1] These cement-water mixtures were gauged to a common flow, the water content averaged approximately 39 per cent of the cement by weight. A study of the results obtained over the twelve months showed conclusively that the fluid cement test was not a satisfactory indicator of the concrete-making qualities of a cement—in fact, that it was not as good as the present tension test in this respect. The results also showed that the tension test was far from being a satisfactory indicator.

Plastic Mortar Test

In planning the work of the second twelve months of research, a change in the program of tests seemed desirable. Since the fluid cement-water mixture has been given a thorough trial and had been found wanting, it was felt that further work with it was not warranted. However, experience with the fluid cement test suggested a modification of it based on the same principle and eventually led to the plastic mortar test with which this paper deals. A plausible explanation of the failure of the fluid cement-water-mixture tests to indicate concrete strengths lay in the great difference between the water-cement ratio in the mixtures and in the concretes with which they were compared.

The fluid cement-water mixtures had a water-cement ratio of about 0.6; the concretes had a water-cement ratio of about 1.00. It does not seem likely that all cements have the same strength relations one to another at both of these water-cement ratios. It seems much more probable that the water-cement ratio-strength curves for cements bear varying relations to one another, that some pairs of curves converge as they pass from one water content to the other, that some diverge, and that some even cross. Such a state of affairs would account for the lack of concordance that has been observed between the results of fluid cement tests and concrete tests of the same cements.

The logical step then was to devise a test using a water-cement ratio of approximately 1.00, thus duplicating the concrete in water content. A fluid cement-water mixture of such water content would be so fluid that segregation would be inevitable in the freshly poured specimens. The problem was to employ a water-cement ratio of 1.00 and to use a mixture of such consistency that segregation or settlement in the molds would be overcome. The introduction of a graded sand to the cement-water mix was the next logical step. A few trials showed that a satisfactory mortar could be compounded with the desired water-cement ratio and apparently made stiff enough to resist segregation in the molds and yet so plastic as to minimize the personal factor of puddling or rodding the specimens. The procedure which has been followed in actual practice has been to use a mortar of 1 part of cement to 2.75 parts of sand, by weight, gauged to the same water-cement ratio as the concrete which was previously made from the same cement sample. The results obtained so far show that in its ability to indicate concrete-making quality this plastic mortar test is better than any other test which has been proposed or used to date.

Methods of Testing

The concrete strengths used as the basis for comparison were obtained through closely controlled tests. This control is the result of a carefully developed and organized routine covering materials, methods and conditions. The main characteristics of the concrete tests are outlined below:

Test Pieces.—3 by 6-in. cylinders.

Proportions.—1 part cement, 2.04 parts sand, and 3.04 parts pebbles, by volume.

Aggregates.—Delaware River Sand, 0 to No. 4; Delaware River Pebbles, No. 4 to ¾ in.; Fineness Modulus, 5.06 ±0.05; Weight per cubic ft., 121 lb.; Colorimetric Value, 0. The sand and pebbles are separated by sieving into seven distinct sizes which are then recombined by weight to insure constant grading of the concrete aggregate.

Mixing.—Each batch is sufficient for ten specimens. Mixing, by hand, is continued for 2 minutes and 20 seconds after the introduction of the water. Concrete is then placed in the flow mold and the flow test is started exactly 3 minutes after the introduction of the water.

Consistency.—80-per-cent Flow (About 6½-in. slump).

Water Ratio.—Varies slightly according to consistency, but is approximately 1.00 or 7½ gal. of water per sack of cement, disregarding absorption by the aggregate.

A paper presented at the Thirty-first Annual Meeting of the American Society for Testing Materials.

[1] "Tests of Fluid Cement-Water Mixtures," Appendix to Report of Committee C-1, *Proceedings'* Am. Soc. Testing Mats., Vol. 27, Part I, p. 307 (1927).

Companion Specimens.—Each concrete value used is derived by averaging the results found for three companion specimens. These companion specimens are made on different days by different operators, so that the effects of personal factor and temperature and humidity are generalized.

Curing.—Specimens stand in the mixing room for 4 hours, then are removed to a damp room where they are capped and stored at 70 deg. F. and 100 per cent Relative Humidity until tested.

Ages at Test.—Six ages as follows: 1 day, 2 days, 4 days, 7 days, 14 days and 28 days.

All tension tests were made in strict accordance with the present A.S.T.M. Standard Specifications and Tests for Portland Cement (C 9—26) with additional specimens for tension tests at 1 day and 3 days. All the work was done by one experienced operator and we have reason to believe that the results approach the practical ultimate in reliability for this type of test.

The fluid cement-water mixtures were made in accordance with the methods and conditions proposed by D. A. Abrams. The water content was governed by a flow test. A flow mold with a capacity of 400 cc. of mixture and with an orifice at the bottom was held above a level glass plate so that the orifice was just 10 cm. above the plate. A trap door in the bottom of the flow mold permitted the flow of the mixture through the orifice on to the glass plate where the 400 cc. of mixture formed a "pan-cake" whose diameter could be measured. The mixtures were gauged to a common consistency such that the "pan-cake" had a diameter of 250 mm. This consistency is similar to that of heavy cream. Two-inch cubes were poured with this fluid cement-water mixture. Pouring was done in the damp room and the specimens were stored there until tested.

The plastic mortar mixes were made with 1 part of cement to 2.75 parts of sand by weight. The sand used was that portion of the concrete sand finer than No. 8. To insure constant grading the sand was fabricated from four sieved sizes of sand. The result was a graded sand with a fineness modulus of 2.23 ± 0.05. The amount of water to be used was determined from the previously made concrete and was calculated to give the same water-cement ratio as used in the concrete, disregarding absorption by the aggregate. The mortar was mixed with an iron spoon in an 11-in. iron stew pan; mixing was continued for 2 minutes and 30 seconds after the introduction of water. Two mortar batches, each sufficient for five 2-in. cubes, were necessary in making a set of ten pieces. The two batches were mixed and poured in rotation, using identical proportions in fabricating each batch. The cube molds were filled in two layers, each layer being rodded 25 times with a ¼-in. rod. A surplus of mortar was left on the mold and was struck off two hours after pouring.

All molding of the plastic mortar cubes was done in the damp room where the temperature has never varied more than 3 deg. F. either way from 70 deg. F. and the relative humidity has been found repeatedly as 100 per cent by periodical tests with a sling psychrometer. The mortar cubes remained in damp room until time of test. All cube specimens were tested on their sides, two of the molded faces acting as the bearing surfaces. A sufficient number of cubes were made to provide a parallel specimen for every concrete cylinder. Thus, every plastic mortar value used is derived by averaging the results for three companion specimens. The three companion specimens in every case were made on different days and by different operators to generalize any personal factor that might exist.

Table I.—Differences in Average Relative Strengths

Differences in average relative strengths between concrete and fluid cement cubes, concrete and standard mortar briquets, and concrete and plastic mortar cubes.

Mill	Fluid Cement minus Concrete							Standard Mortar minus Concrete					Plastic Mortar minus Concrete						
	1 day	2 days	4 days	7 days	14 days	28 days	Average	1 day	3 days	7 days	28 days	Average	1 day	2 days	4 days	7 days	14 days	28 days	Average
1	−6	−15	−14	−20	−22	−19	−16	−9	−19	−15	−10	−13	−6	+1	+3	+2	+2	0	0
2	−29	−23	−26	−25	−24	−10	−23	−9	−8	−6	−7	−8	−10	−5	−6	−5	−9	−9	−7
3	−11	−11	−10	−10	+6	+9	−4	+6	−10	−7	−3	−4	+3	−2	+1	+9	+6	+2	+3
4	+11	+4	+3	+4	+3	+1	+4	−4	−5	−8	−3	−5	+11	+6	+2	+3	+4	+1	+4
5	−1	−4	−12	−9	−14	−9	−8	+8	0	−11	−7	−2	+8	−8	−11	−2	+2	+5	−1
6	−1	+5	−2	0	0	+3	+1	+7	−1	−10	−5	−2	−4	−1	0	−1	+3	+4	0
7	−9	−13	−14	−12	−12	−7	−11	−1	0	−11	−5	−4	+8	+4	+4	+4	+4	+2	+4
8	+3	+2	+1	+2	−5	−5	0	−12	−2	+3	+2	−2	−1	0	+5	−1	+1	+4	+1
9	+1	+5	+7	+4	+9	+7	+6	−28	−10	−3	+6	−6	−2	+1	−4	−1	+3	−4	−1
10	−9	−8	−12	−9	−11	−13	−10	+11	+8	+2	−5	+4	+1	+1	−4	−5	−5	−1	−2
11	−4	+1	0	+2	−2	0	0	−5	+3	+5	+3	+2	+5	+1	+2	+2	−1	+2	+2
12	0	0	+2	+6	−1	−5	0	+16	+12	+4	−1	+8	−2	−6	−1	+2	+3	−2	−1
13	+11	+12	+15	+13	+8	+1	+10	−1	0	+6	+5	+2	−3	−2	−2	−1	−2	0	−2
14	+10	+13	+14	+9	+6	0	+9	+11	+11	+17	+17	+14	+1	−1	+1	−1	−1	0	0
15	+15	+8	+12	+10	+8	+4	+10	+18	+8	+9	0	+9	−1	−1	−1	−3	−4	−3	−2
16	+6	+8	+5	+7	+16	+14	+9	−1	+4	+4	+4	+3	−4	+2	−1	0	0	−1	−1
17	+16	+22	+26	+22	+22	+16	+21	−13	+8	+16	+13	+6	+1	+6	+6	+3	+6	+7	+5
Grand Average Differences.....							8.4	....	....	....	....	5.5	....	....	....	....	....	....	2.1

NOTE.—The 3-day differences for the standard mortar are calculated as the differences between the 3-day standard mortar relative strength and the average of the 2-day and 4-day concrete relative strengths.

The concrete relative strength is used as the basis for the computation; the plus sign denotes the indicator test as showing a higher relative strength than did the concrete, and the negative sign denotes the indicated relative strength as lower than the concrete relative strength.

Presentation of Data

Due to the differences in absolute strengths of the concrete cylinders and the various indicator test pieces, it became necessary to develop a system of "relative strengths" in order that the several tests might be fairly compared. This was done by determining the average strength for all of the cement samples as revealed by any type of test, concrete, fluid cement, standard mortar, or plastic mortar, at a given age, calling that 100, and then expressing the corresponding strengths of individual cements as percentages of that average. For example, if the average concrete strength for all cements at 14 days were 2000 lb. per sq. in. and a certain cement developed a concrete strength of only 1800 lb. per sq. in. then the concrete relative strength of that cement at that age would be 90. The several indicator tests could be exemplified in the same way. To judge the value of any indicator test, therefore, for its ability to predict concrete-making qualities, the relative strengths shown by that test may be compared with the corresponding concrete relative strengths. The more closely these relative strengths coincide the more satisfactory is the indicator test.

Trends of Products

Table I is presented to show the differences in average relative strengths between concrete and the several indicator tests for each of seventeen mill products at each test period up to 28 days. The values are not derived from a single test; they are computed by averaging the results for monthly samples from respective mills over an extended period. The concrete-fluid cement comparisons are based on monthly tests over one year; the differences shown for the other two indicator tests are derived from the data of six months. Thus, the differences recorded cannot be attributed to the possible uncertainties of a single test, but are averages that show *real trends* for the respective mill products. For the fluid cement differences each value is derived from 36 tests; for standard mortar and plastic mortar each individual difference presented is derived from 18 tests. Attention is called to the grand average differences, which may be considered as a measure of the faithfulness of each type of indicator test.

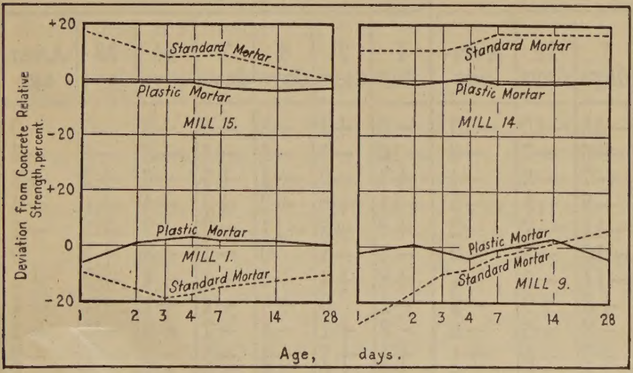


FIG. 1.—Comparison of Relative Strengths of Cements in Standard Mortar (Tension) and Plastic Mortar (Compression) with Concrete Relative Strengths.

In Figure 1 relative strength curves have been prepared which show the deviation of tensile strengths and plastic-mortar strengths from the concrete strengths for four different mill products at the several test periods up to 28 days. The data for these curves were taken directly from Table I. Each set of curves was chosen to exemplify a characteristic misinterpretation of cement quality which may be encountered with the standard tension test. For example, the tension tests for Mill 1 indicate a lower concrete quality than actually exists, while for Mill 9 the tension tests show a higher rate of strength gain than actually occurs in the concrete. Attention is called to the favorable indications of the plastic mortar test in every case.

In Figure 2 a slightly different scheme of comparison is used. By averaging the relative strengths at all ages up to 28 days a figure is obtained which is termed "relative strength level." Here again, if an indicator test functions perfectly it should rate any mill product at the same relative strength level as does the concrete test. The mill products are arranged in order of descending concrete relative strength levels. The fluid cement-water mixture values are averages for performance over twelve months, the plastic mortar and standard tension mortar values are averaged for six months.

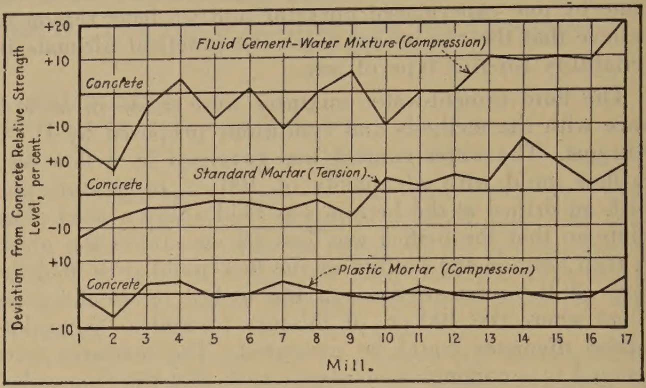


FIG. 2.—Comparison of Relative Strength Levels of Cements in Three Types of Indicator Test with Concrete Relative Strength Levels. The Mills are Arranged in Order of Descending Concrete Relative Strength Levels.

A detailed discussion of these curves seems unnecessary. The general slopes of the fluid-cement line and the standard-mortar line show that both of these tests tend to penalize the high-strength cements and to give too high a rating to the low-strength cements. In the case of the fluid cement-water mixtures the value shown by the indicator test differs from the actual concrete value by more than 5 per cent for eleven out of the seventeen mill products, the average difference for all is 8.4 per cent. The tension test is "off" by more than 5 per cent for six out of the seventeen mill products and the average difference for all is 5.6 per cent. The plastic-mortar test is 7 per cent low for Mill 2; in all cases it is within 5 per cent of the concrete value and the average difference for all is 2.1 per cent.

Table II is presented to show the ratios of the absolute strengths in each type of test to the absolute concrete

Table II.—Ratios of Absolute Strengths

Ratios of the absolute strengths of fluid cement compression cubes, standard mortar tension briquets and plastic mortar compression cubes to the absolute strengths of the corresponding concrete compression cylinders at the several test periods.

Age, Days	Fluid Cement Concrete	Standard Mortar Concrete	Plastic Mortar Concrete
1	3.36	0.43	1.03
2	3.16	——	1.05
3	——	0.28*	——
4	3.06	——	1.10
7	3.22	0.19	1.12
14	3.08	——	1.13
28	2.77	0.13	1.14

**The ratio noted for the 3-day standard mortar strength is the ratio of the 3-day standard mortar strength to the average of the 2-day and 4-day concrete strength.*

strength. It may be noted that the plastic mortar ratios are close to unity, so close as to assume a very important practical significance.

Table III.—Average Variations of Companion Plastic Mortar Specimens from Their Own Average

The variations shown are averages for all mill products tested during two different months. Variations are expressed as a percentage of the average.

Month	1 Day	2 Days	4 Days	8 Days	14 Days	28 Days	Ave.
September, 1927	5.2	4.7	5.6	5.1	5.4	3.6	4.9
October, 1927	5.4	4.7	3.9	4.1	5.3	4.7	4.7
Average	5.3	4.7	4.8	4.6	5.4	4.2	4.8

In describing the method of test it was stated that the plastic mortar relative strengths were computed by averaging the results for three companion specimens which were made by different operators and on different days. Table III shows the average variations of the three companion specimens from their own average for each age and for all mill products tested in two different months.

Discussion of Results

There are certain cardinal features which should always be incorporated, if possible, in devising any specification test. These features are: (1) faithfulness in indicating quality; (2) minimum variation in test results for companion specimens or repeat tests; (3) freedom from sensitiveness to the personal factor or other secondary influences; (4) simplicity in all of the operations of testing; and (5) low cost.

Examination of Figures 1 and 2 and Table I shows the superiority of the plastic mortar test in faithfully indicating the concrete-making qualities of cement. Figure 1 and Table I show studies of the accuracy of the indicator tests at each test period. Figure 2 compares the indicator tests in a different manner and brings out the same conclusion as to the superiority of the plastic mortar test as an indicator of the concrete-making qualities of cement. The average deviations of Figure 2 and the grand average differences of Table I are dependable indications of the accuracy of each type of test, as they are based on a large amount of data derived from carefully controlled tests extending over a considerable period of time.

The plastic nature of the mortar used in this indicator test is such as to reduce to a practical minimum the personal factor of rodding or puddling the cube specimens. The sand is graded to enhance plasticity and the mix is wet enough to insure easy working in the molds. In studying the variations among companion specimens (Table III) it should be remembered that the companion specimens were made on different days and by different operators. The variations at 1 day are comparatively high, as might be expected, and yet the grand average variation of 4.8 per cent indicates very good agreement. In the report of co-operative tests of 32 cements by 47 laboratories, conducted last year by Committee C-1 on Cement of this Society, a weighted average variation of 3.8 per cent was found among companion tension briquets, but these companion specimens were made from a single batch by a single operator on the same day so that the conditions were far more favorable for small variations.

The fabrication of plastic mortar cube test pieces is simple; the procedure closely parallels that of the fabrication of concrete specimens. The cube test piece offers added simplicity in that no capping is necessary, since two of the molded sides are used as bearing surfaces during testing. The specimens are tested in a compression machine; the operation of centering the specimen in the testing machine requires care but is simple with suitable equipment.

The principle of the plastic mortar test is based chiefly upon the use of a water-cement ratio identical with that of the accompanying concrete. In these pioneer tests it was necessary to use a single sand of carefully controlled gradation in order to be certain that any irregularities in results which might occur were not due to variations in sand. If water-cement ratio is the governing factor in this test, the possibility exists that satisfactory and comparable results may be obtained by widely separated laboratories using clean sands of local origin graded within certain limits, by the mere use of equivalent water contents. If this is true, the necessity for a single standard sand in cement testing would be removed.

The absolute strengths of the plastic mortar cubes agree fairly closely with the concrete strengths, as may be seen by Table II. In fact, the differences recorded might be attributable to the difference in size and shape of the two types of test pieces. The practical significance of this feature of the plastic mortar test should not be overlooked. The agreement in absolute strength between plastic mortar and concrete is so close that the plastic mortar test offers a rough means of making a direct determination of the concrete-making qualities of any cement.

The plastic mortar test has several desirable features and offers some interesting possibilities as a specification test for cements to replace the present tension test. The plastic mortar test has all of the advantages that have been ascribed to the fluid cement test and one or two advantages which the latter does not have. They may be summed up as follows:

1. It gives a more nearly correct measure of the concrete-making qualities of cement than does any other indicator test used or proposed to date.
2. The plasticity of the mortar minimizes the effects of personal factor of operators and of minor variations in technique.
3. Specimens are more easily made than in the case of standard Ottawa sand mortar because the mix is plastic and more easily worked.
4. It may, though it has not yet been shown that it surely will, obviate the necessity for a single standard sand.
5. It offers an entirely feasible means for making early strength tests. With good control, tests at 24 hours have been shown to be in close agreement with concrete tests at that age.
6. The absolute strength of the plastic mortar is fairly close to that of the concrete. In the tests described here the differences in absolute strength could be ascribed to differences in size and shape of specimen: 3- by 6-in. cylinders for concrete and 2-in. cubes for the plastic mortar.

Complaint Charges Association with Unfair Competition

September 19th has been set as the date for the hearing of the complaint filed with the federal trade commission at Washington, D. C., against the Portland Cement Association, charging the latter with unfair methods of competition.

The complaint alleges that the association has endeavored to control the awarding of road construction contracts. It is also claimed that verbal, written and printed disparaging statements concerning the products of the American Vibrolithic Corporation, a competitor, have been made.

Painless Bookkeeping for Products Plants

An Advance Announcement of a Series of Articles

CONCRETE products manufacturers everywhere are facing keen competition. In many localities prices are falling to new low levels. Too often this condition is brought about by irresponsible manufacturers who sell at any price to get the business regardless of cost.

Many such irresponsible manufacturers will, in time, automatically eliminate themselves. No business can operate for a long time at a loss. But even when they are eliminated, competition will continue to be keen. We are in a buyers' market and will continue to be. Purchasers of concrete products can buy critically both with respect to price and quality for the simple reason that existing concrete products plants can turn out more block than are now being sold.

Such a condition inevitably leads to lower prices. The farsighted manufacturer takes these trends into consideration and makes his plans accordingly. How low the market price can be cut, and still yield a margin of profit, is a problem that every manufacturer must work out for himself, according to his own conditions. Obviously, he cannot sell his product for less than it costs him to make it, if he is going to continue in business.

"The secret of business success in the next decade lies with inside management," said Roger Babson in a recent report. The first need is to *know what it costs to make the product.* That being known, the manufacturer can fix the lowest price at which he can afford to sell his product. Also, when he knows his costs, the way is often opened up to substantial operating economies that were not apparent before.

Many articles have appeared on cost accounting for products plants. Many lectures have been given at conventions on this subject. Products manufacturers as a whole are alive to the need of a method of keeping their records and some of them have cost accounting systems in effect.

But there are many others who have not yet found a method that is simple enough or practical enough for their use. Others have found the method they are using too cumbersome or too incomplete. Practically all of them are interested in finding a method that will give them accurate, dependable cost information with a minimum of effort. They are not accountants and the methods previously given them have been difficult to understand and to put into operation.

F. W. Schnoebelen, the author of the articles on products plant bookkeeping that will begin in the next issue, has designed a practical method of keeping such records, which he describes in these articles. He did not present this method as a help for others until he himself had tried it out thoroughly in his every-day work as office manager for A. W. Friske, Milwaukee concrete products manufacturer. The method is the result of his experience in keeping office records for a concrete products business.

Simplicity and brevity are the keynotes of the method. It calls only for such information as is needed to give an accurate history of the business transactions. It will not require an accountant or the purchase of an expensive set of books and record forms. In designing this method, Mr. Schnoebelen had only products manufacturers and their problems in mind. The method can be adapted to a business producing a million units per year, or one producing ten thousand units per year.

A products salesman comes into the office and hands in an order. What happens in the plant and in the office as a result of this order? How are the records carrying an account for all the transactions involved kept? How much did it actually cost to sell, manufacture and deliver the units in that order? Did the manufacturer make a profit when the deal was finally completed and the block were in the wall?

All these things will be explained fully and simply. An imaginary month's business, involving every transaction that is necessary to a products business, will be followed through each particular section of the system. The first article will discuss production records. In it records for a month's operation will actually be kept and analyzed. All that will be necessary to install the system in another plant will be to substitute your figures for those given in the story.

The second article will discuss sales records and methods of keeping them. When the order is handed in at the office an estimate and order sheet is prepared. Then the block are either taken from stock or are made up in the plant. A simple and concise method of keeping track of deliveries is given and all through the discussion, bits of advice as to methods of dealing with contractors and owners are given, based on actual experience in the products business. How are the invoices made out? How is close tab kept on the units in stock while new units are being made and orders are being filled? These are questions that are answered in this second article.

The third article goes into the actual bookkeeping required and gives a complete classification of accounts needed in a concrete products business. Each account is explained in detail and instructions are given as to just which transactions are to be debited to one account and credited to another. As the discussion continues, actual transactions as are made every day in a products plant are recorded in their proper places and the reasons for doing so are explained. The posting chart is presented so that any manufacturer with a slight knowledge of bookkeeping can adapt it to his needs.

In the next article, the books of a hypothetical concrete products plant are actually opened and an imaginary month's business is recorded. The following installment discusses "accounts payable" and tells how credit is made use of in modern business dealings. Next comes a detailed discussion of "cash" transactions and how they are recorded.

The last two articles describe the business man's method of "checking up" at the end of the month to see how things have been going. He makes an inventory of his manufactured stock and his raw materials. He compiles a "profit and loss" statement which gives him a bird's-eye view of the month's transactions and he makes a "cost sheet" that tells him at a glance what each division in making and selling the product cost.

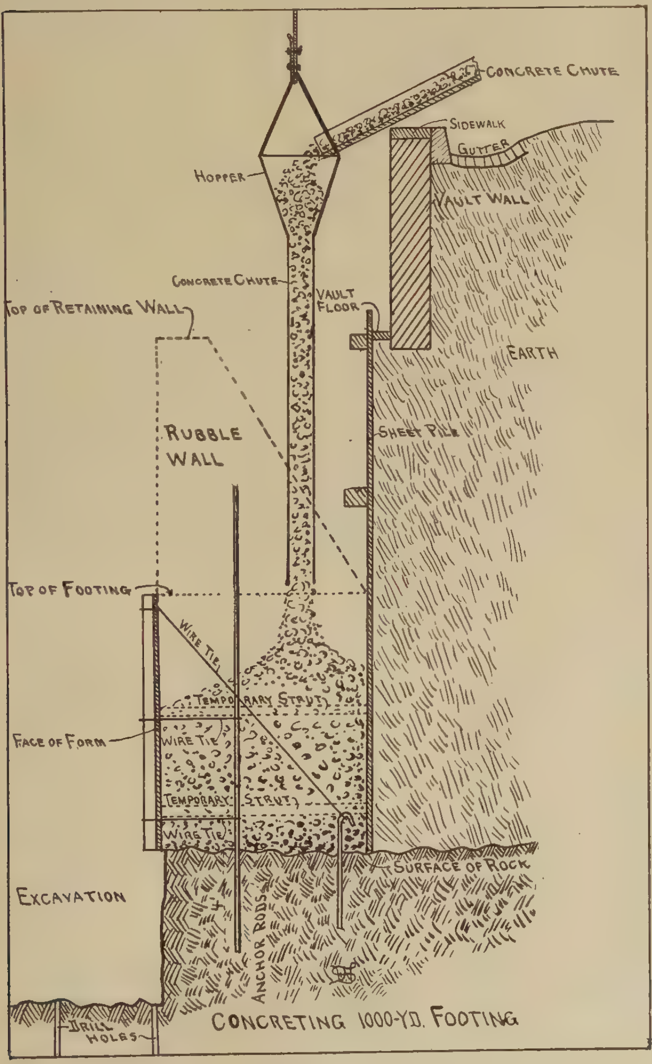
All these facts are easily taken from the records explained in the previous articles. It is surprising what a wealth of information can be taken from a simple set of records when they are designed for a definite purpose. Without such records it is impossible to know how things are going. With them, facts are available that not only give a picture of the state of the business at any time, but they point out accurately any weakness that exists in any of the departments. When these are known to exist and are located, improvements can be made that will reduce manufacturing or selling costs.

It is recommended that products manufacturers file these articles as they are published so that they will act as a guide to the installation of similar methods in their plants. Every form that is needed for keeping the records will be reproduced filled in with the transactions the imaginary plant makes during a month's business. Any products manufacturer can substitute his items for those given and so start on the road toward an accurate and helpful record of his business dealings.

Deep Concrete Base for 45-Story Building

One Thousand Yards of Wide Concrete Footing Anchored to Bed Rock and to Retaining Wall—Costly Construction Eliminated—Methods Used

DURING the construction of the foundations for the New York Life Insurance Company building which is now occupying the site of the famous Madison Square Garden in New York, it was found that it was more economical to place 1000 cubic yards of concrete footing and retaining wall than to use the massive temporary steel sheeting and bracing that would otherwise have been required. The method adopted entirely eliminated the obstruction of the pit by the many long inclined braces or horizontal transverse struts that would have been necessary, and which would have offered serious obstruction to excavation and which would have constituted a hazard for the blasting, excavation and hoisting operations.



Method of placing concrete for retaining wall footing

The George J. Atwell Company, Inc., were the contractors for excavating the 23,000 cubic yards of earth and the 125,000 cubic yards of hard gneiss rock. As fast as the excavation uncovered short sections of the rock surface at depths from 15 to 40 feet below the curb, the vertical earth walls, which had been carefully trimmed to avoid unnecessary disturbance, were sheeted with wooden planks which retained the embankment until the unsound upper layer of rock could be removed where that was necessary. At the same time a gang of carpenters built an inside form for a concrete footing averaging about 8 feet in width and varying from 3 to 15 feet in height. This footing formed the base of a continuous masonry wall, 2 feet thick at the top and battered 4 to 10 to serve as a permanent gravity retaining wall.

Vertical deformed anchor bars 1½ inches square and long enough to project 4 feet above the top of the concrete and bond it with the rubble masonry above were first set in holes drilled from 2 to 3½ feet apart. The vertical spaces of the forms, in lengths of 10 or 15 feet, were then built in place and wired to the anchorage or if necessary to an extra row of dowels set for that purpose. The front form was pulled tight against temporary horizontal struts and the 1:3:5 gravel concrete was mixed immediately above the form and chuted to position from a portable Smith mixer.

In this way a massive footing that contained about 1000 yards of concrete was built to form a uniform horizontal base for the stone wall above and both base and wall proved adequate to retain the earth pressure and any supercharge that might come from the street traffic which was kept back some distance from the face of the wall by the high board fence that enclosed the excavation and provided at street level a working platform adequate for the installation of storehouses, sheds and the like.

An Accurate Method for Determining Actual Areas for Deformed Steel Reinforcing Bars

By M. K. SCHEIRER
Physical Testing Engineer, Division of Tests, Tenn. Dept. of Highways and Public Works

THE writer has employed the methods known at present for determining the actual area of deformed steel reinforcing bars: namely, micrometer caliper, and planimeter methods. Results obtained by these methods were questioned from time to time by interested parties, and, after comparing all methods, the displacement method was found to be more accurate than either of the above mentioned.

My experience has been that in using a planimeter, the ends of the test pieces make a sharper outline or impression if the ends are slightly countersunk. A lathe will be necessary in this case. It was found that filed ends gave faint or broken outlines which forced the person operating the planimeter to assume an imaginary line for possibly ⅛-in., which is not desirable when the quality of a deformed bar is in question. The table of results accompanying this article will be found interesting when compared with the table accompanying an article by D. O. Woolf of the Bureau of Public Roads, in "Public Roads," July, 1926.

The displacement method for determining the actual area which has been in use for the past year by the Division of Tests of the Tennessee Department of Highways and Public Works is comparatively simple.

A piece of the steel to be tested is cut through at right angles to its axis, approximately 6 in. in length, and is accurately measured with a caliper and steel scale graduated in hundredths.[1] A piece of No. 32 gauge copper wire is then twisted around one end of the test piece to aid in holding it. The test piece is then immersed to about one-quarter of an inch below the surface of the water in the graduated cylinder, which contains a known volume of water (W).[2] A second reading of the graduate is then recorded (W_1) and the difference between the final reading (W_1) and the initial reading (W) equals the displacement. You then have the equation:

$$A = \frac{W_1 - W}{2.54^3 L}$$

Where A = area (sq. in.)
W = initial volume
W_1 = final volume
L = length of test piece (inches).

A 250 c.c. graduated cylinder is used for sizes to and including ⅞ in., and a 500 c.c. graduate for the larger sizes.

The writer believes this method has the advantage over other methods in that by displacement the average of an infinite number of cross-sections may be obtained simultaneously.

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[1] If a mechanical back saw is not available, a hand cut piece with ragged ends removed by the use of a fine file will prove satisfactory. The Tennessee Division of Tests uses a blade having twenty-two (22) teeth per inch.

[2] The volume displaced by the wire is so small that it does not alter the final reading.

How Stability Will Be Restored to Pisa's Leaning Tower

The engineers of the Francois Cementation Company, which is to undertake the work of strengthening the foundation of the Leaning Tower of Pisa, will first prepare the ground and subsoil some 50 yds. away from the present foundations of the tower to test the resistance of the soil, which is partly mixed with moving sand, gravel and running water. The process to be used consists of certain chemical applications, followed by injections of specially-prepared cement. The company will shortly send one of its best engineers, with machinery, skilled workmen and a foreman.

It is said that, in the course of the last 50 or 100 years, the famous tower has rather accentuated its inclination, and it is now supposed to be moving slightly at the rate of one millimeter (0.039 inch) per year. According to this estimate, it would take at least 200 years for the center of gravity of the tower to fall outside the perpendicular. One precaution which has been suggested is to drain thoroughly a large area within hundreds of yards of the tower and the cathedral of all water, and to prevent any further possible infiltration of moisture, which makes the foundations soft and causes them slowly to yield.

TABLE I

COMPARISON OF ACTUAL AND NOMINAL CROSS-SECTIONAL AREAS OF BARS AND UNIT STRENGTHS BASED ON EACH

Sample No.	Size and Shape of Deformed Bar	—Area of Cross Section— Nominal, Sq. In.	Actual, Sq. In.	Breaking Load, Lbs.	—Unit Tensile Strength— Nominal Lbs./Sq. In.	Actual Lbs./Sq. In.	Difference in Nominal Unit Tensile Strength Lbs./Sq. In.	Per Cent
1	½-in. rd.	.1963	.1936	11,490	58,532	59,349	817	1.4
2	½-in. rd.	.1963	.1932	12,670	64,544	65,580	1036	1.6
3	½-in. sq.	.2500	.2444	19,685	78,740	80,544	1804	2.2
4	½-in. sq.	.2500	.2433	18,490	73,960	75,996	2036	2.7
5	½-in. sq.	.2500	.2441	16,150	64,600	66,161	1561	2.4
6	½-in. sq.	.2500	.2437	16,320	65,280	66,967	1687	2.5
7	¾-in. rd.	.4418	.4373	36,145	81,813	82,655	842	1.0
8	⅞-in. rd.	.6013	.6123	44,540	74,073	72,742	1331	1.8
9	1 -in. sq.	1.0000	.9882	72,490	72,490	73,355	865	1.2
10	1⅛-in. sq.	1.2656	1.2777	103,110	81,471	80,699	772	0.9
11	1⅛-in. sq.	1.2656	1.2836	88,575	69,986	69,000	986	1.4

NOTE: State of Tennessee allows use of both structural and intermediate grades in same job. Each bar was submitted as size shown in table.

~ EDITORIAL ~

Products Associations Accomplishments

CONSIDERABLE time will yet elapse before the various local and the national concrete products associations meet. But already those influential in the affairs of these organizations are giving much serious thought to the problems of organization and association activity that will come up for discussion.

In an industry that has been growing as rapidly as the concrete products industry, there are many opportunities for co-operative work. Concrete products have not yet reached the point where all available markets have been tapped. There is still much promotional work to do and there are still many operating and management problems to solve. Only a portion of the industry's possibilities have been realized. Aggressive association activities will do much to help the manufacturers realize these possibilities.

The local and state associations are functioning aggressively. Their meetings are helpful and usually well attended. Their officers are in close touch with the members and with the members' problems. Such associations have been of real value and service and because of that they are willingly supported.

The work of the national association has not been of such vital importance to products manufacturers in the past year or two. For some reason or another there has been little aggressive effort toward meeting the needs of the products manufacturers as a national group.

Perhaps this was due to the fact that the officers were so widely scattered or to the indifference of products manufacturers to the communications sent out by the association or to the form of organization of the association itself. Whatever the cause, it is necessary that products manufacturers find some way to attack their common problems co-operatively. There are many progressive, far-sighted men in the industry. When these men set themselves the task of analyzing the situation seriously, some helpful suggestions are sure to be brought forth.

It may be that a reorganization of the national association in any one of a number of ways may meet the needs of the members more completely.

Some industries accomplish things best as independent local organizations. Some operate as a federation of local organizations. Others as local organizations with a policy—forming national council composed of representatives from the local bodies. Perhaps some other form of organization than the present one would enable the concrete products industry to function more effectively.

It is not our purpose to recommend or to suggest any change in the concrete products association. The point is merely raised that there are great potentialities for the industry which could be brought nearer to realization if the efforts of all products manufacturers and of all the local associations were co-ordinated in some manner.

There are still a number of months before the national association will meet. There is time to consider and discuss methods. It is not too early now to formulate ideas and make suggestions. Products manufacturers are invited to present their suggestions for publication and discussion.

Lengthen the Construction Season

THE crickets are singing—an indication that fall is not far off. But an increasing number of contractors are not going to let the coming of fall interfere with bidding on additional work that will take them on into the winter.

Time was—and not so long ago—when the first signs of fall were a warning to the contractor not to take any more work. He was afraid he would get stuck with the job when cold weather came on.

Each year additional contractors are finding that cold weather need not interfere with the placing of concrete. The advantages of a longer operating season and of keeping the organization intact more than offset the slight additional cost of winter work. It's good business to keep right on going.

Central Mixing Plants

THE permanent central mixing plant is making a definite place for itself. Each year more cities are being served by them. Almost without exception they are meeting with success.

It is now pretty definitely established that well made concrete can be hauled reasonable distances without detracting from the strength of the concrete. When the central mixing plant was first introduced for concrete highway construction, there was much doubt as to its value. But the economies in operation and the close control that could be exercised over the quality of the concrete produced won a place for it.

Similar advantages may be claimed for it in other than highway work. In one city, concrete was looked upon with much disfavor because of some poor concrete that had been placed on the city's streets. A central mixing plant, installed in that city by a man who knew the principles of making good concrete and who insisted on quality concrete, brought this material back into favor.

There lies the opportunity for central mixing plants. Much concrete is still being placed on many smaller jobs without adequate supervision and by contractors who do not know or are indifferent. The central mixing plant could supply quality concrete for such work at a cost little if any greater than it costs to make inferior concrete on the job.

P. G. RILEY
President

P. G. RILEY

GENERAL CONTRACTOR

~~701 Temple Street, Pittstown, N. Y.~~

T. G. McGOVERN
General Supt.

Los Angeles

Dear Mac:

In your last letter you very casually mentioned that you passed up the opportunity of trading in the "Wreck of the Hesperus," even though you were offered $3,000 for it as a first payment on a new shovel, the balance to be stretched along for nearly two years.

Yes, you mentioned it casually, but when I read it, I yelled, "Atta boy, Mac," so loud that Mother, who was dozing in her chair on the front porch, jumped causing her glasses to drop on the tile floor and break.

Here I am out in California, taking a bird's-eye view of the industry, and what I see, Mac, makes me think that everyone in it had better take a shot of something that will stiffen up their backbones. The equipment manufacturer, faced with over-production, is crowding the equipment distributor, already troubled with a problem of high cost of selling and servicing, with no increase in his discounts since equipment was being sold by desk salesman—crowding him with high-pressure sales methods to accept unprofitable trade-ins and long-time payment propositions from the contractors. The contractor takes advantage of this situation by playing one distributor against the other, thereby disposing of machines already charged off their books, thinking the manufacturer and distributor have added to their prices a sufficient amount to enable them to make trade-in allowances. By so doing, he is just helping some irresponsible contractor to get into business as a competitor, because the distributor is surely going to sell those used machines and most of them go to irresponsible contractors. Not only that, but the concern making the most attractive trade-in allowance doesn't always have the best machine to sell.

What are the people in this industry now, Mac? Why, just a bunch of horse traders, who kid themselves into thinking they are clever business men, until their attention is called to their financial statements, which often give them a headache and they yell, "My God, something must be done about it," and off they go to their associations, each with an original idea and when he gets up on his feet to explain it, finds that all the rest of his brothers are on their feet, too, so that instead of the solo part, he finds he is singing in a chorus, which had planned to sing, "Hail! Hail! the Gang's All Here! What the Hell Do We Care Now?" but instead they sing, "Hey! Hey! There's Too Much Gang Here! Somebody's On My Poor Feet Now." So they resolve to resolve that the equipment manufacturers, building supply dealers, bonding companies and equipment distributors have, by easy terms, low priced used machines and easy bonds, left the gates of the industry open and a lot of irresponsible contractors have roamed in and messed things up in general.

It is open season now for associations—manufacturers' associations, distributors' associations and contractors' associations—resolving and resolving and passing the buck back and forth, when every one of them lives in a glass house.

"Now, who's wrong?" the chairman asks.

Hell, everybody's wrong but me," each one answers. And it will be that way 'til Hell freezes over, unless they destroy tons of resolutions and each one makes a solemn resolution of his own, to clean his own house first—then lay the cards on the table.

Why make a secret order out of every business? What is so terribly wrong about the manufacturer, distributor, contractor and sub-contractor showing their cards to each other? You would think profits were the misdeeds of a misspent past, when everyone is so secretive about them. It would seem to me that if there were a thorough understanding of each other's costs, profits and problems, they could by co-operation wipe out most of the unsatisfactory and unprofitable present-day practices.

Well, Mac, Jim Brundage, now a retired concrete mixer manufacturer; Bob Clement, now a retired building supply dealer, and myself, now a retired but not entirely dormant contractor, solved this thing years ago when we were in action. A great many years ago, every time I got a job, there was a wrestling match among us three, to see which was the cleverest, until Jim said to me one day, "P. G., call up Bob and let's go fishing," and we did, but we brought something back with us besides fish. When we got nicely settled in a boat and each had taken a chew from the same package of "scrap," Jim said, "Listen, fellows, here we are today all in one boat and we were yesterday and we will be tomorrow and several tomorrows all in the same boat, but if we act today as we have acted in our yesterdays, sometime on a nearby tomorrow the boat will get to rocking and dump us all out. Now, P. G., I am building mixers for you. Do you help me design them? You do not. You tell me I rob you when I sell them to you. Now, wait a minute. None of us can swim, so let's don't get rough. Here's what I am getting at. Suppose we try out an experiment. The three of us will be the three musketeers, all for one, one for all. We will know each other's costs, profits and troubles and cut out this deep mystery of buying and selling and this matter of profit," and we did. After that, when I got a job, these men would play with me and I with them, in a way that usually made us all a profit.

I am glad you did not buy trade-in talk, long-term talk or even selling talk, but that you did buy the shovel you thought best for your work, and I would suggest that you take the "Wreck of the Hesperus" over to the wreckers, so that some irresponsible contractor doesn't wreck himself with it and cripple everybody with whom he comes in contact.

Sincerely yours,

P. G.

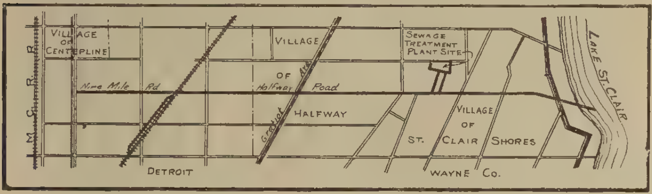
Early Strength Concrete Required in Building Shallow Depth Drain

Reinforced Concrete Construction Makes Possible Double Box Drain with Top Slab Near Pavement Grade—Various Construction Methods Adopted to Meet Conditions, Including Use of Early Strength Concrete—Pavement Closed for One Night Only

By DWIGHT F. JENNINGS

EXACTING conditions somewhat unusual in sewer construction in the Detroit Metropolitan district were met in connection with construction of the Nine Mile-Halfway drain in Macomb County, Michigan, requiring in one section of the structure the use of concrete developing high early strength.

The entire project is one of the largest sewer and sewage disposal projects ever attempted under the present Michigan drain laws. The drain is approximately 7½ miles long, extending in an easterly direction from Van Dyke Avenue to Lake St. Clair, in the vicinity of Detroit. It drains about 11 square miles, including parts of Halfway, Center Line and St. Clair Shores villages, as well as other thickly populated sections of the county, not incorporated.



The general location plan of the 9-mile halfway drain

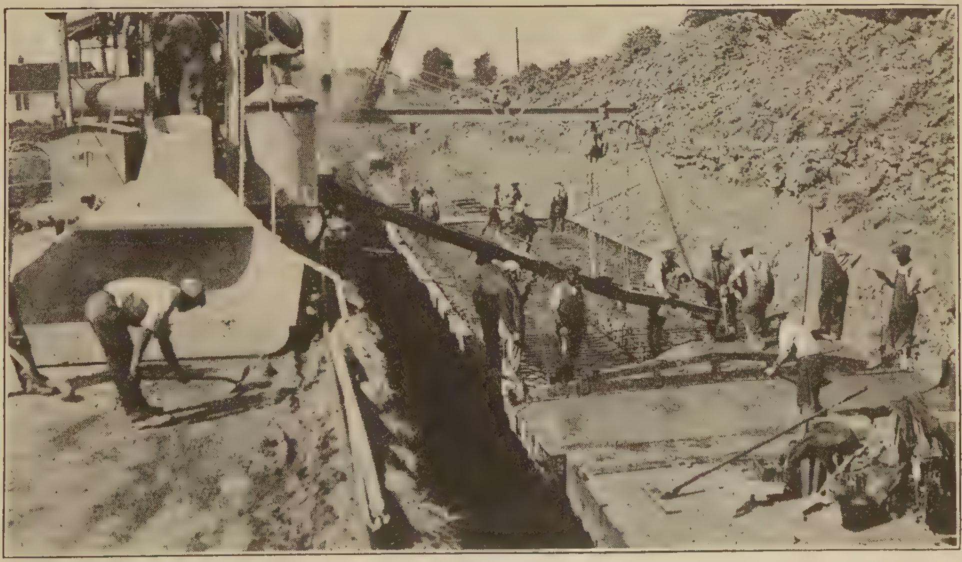
Owing to the nature of the land drained, the territory being comparatively flat with very little fall in the lower 2½ miles at the outlet end, a double barreled box section was adopted for the lower end. In the outlet section of the project the top of the sewer is level with the top of the pavement for a considerable distance, and for a mile near the lower end it is not more than 12 in. below the pavement grade.

Early Strength Concrete at Highway Crossing

The section of the sewer requiring special attention for high early strength concrete comprised a 62 ft. length of reinforced concrete box drain, each box being 7 ft. 2 in. by 8 ft. 6 in. At this point it was necessary to construct the sewer across Harper Avenue, a main improved highway which could not be closed to traffic and under which it was impossible to tunnel because of the shallowness of the sewer. The early strength concrete was produced by the use of a strong standard portland cement, with properly proportioned aggregates, and by carefully controlling the water-cement ratio.

The contractor was permitted to close this road for one night only between 11 P.M. and 5 A.M. During this short interval while traffic was interrupted, a section of the pavement was removed and a temporary I-beam bridge

Showing the paving mixer, operating along the right-of-way, discharging into forms for the double box section



was constructed across the sewer excavation with a span of 30 ft. supported on timber bents.

As this condition of the highway would only be permitted for one week, it was necessary to hasten concreting so as to again open the road to normal traffic. The early strength concrete produced with standard portland cement was subjected to the complete load of backfill and traffic in minimum time, a check on the strength of the concrete being made by means of test cylinders made from the concrete as it went into the forms. The necessary heavy reinforcing steel and thin walls of the section contributed to the exacting conditions that had to be overcome. Various expedients were considered for hastening concreting operations and after thorough investigations the use of high early strength concrete with standard cement was selected.

The specifications prohibited the use of integral waterproofing. On certain indicated sections alternate bids were asked for construction, using a special cement. After a trial section was placed the use of the special cement was abandoned. Inspections of sections of the completed work by the engineers, particularly of a section through quicksand where standard and special cements were used showed very little infiltration of ground water, and there was no visible difference in the resulting concrete where the different cements were used.

Control Methods

The sewer section was designed to carry a load equivalent to two 18-ton trucks, and due to the heavy reinforcement required with thin walls, in the box section at the Harper Avenue crossing, a portland cement concrete mixed 1:1½:3 was used by the contractor, requiring 1.85 barrels of cement to a cubic yard of concrete.

The contractor increased the mixing time of each batch to three minutes and reduced the slump to a minimum consistent with the proper workability under the conditions. There was no accurate way available for gauging the mixing water used per sack of cement, because of the moisture present in the aggregate. The judgment of the mixer operator, and the slump tests were relied upon to produce the desired results.

Compressive strength tests were made on 6- by 12-in. cylinders at the age of seven days, the results of which showed that the concrete developed strengths considerably higher than the 2000 lbs. per sq. in. required, the average being 2370 lbs. per sq. in. One cylinder broken at the age of three days to obtain a preliminary idea of what could be expected at seven days, gave a compressive strength of 1256 lbs. per sq. in. Slumps ranged from 2 in. to 4 in.

Field control of the concrete was maintained throughout the entire project by means of compression tests on standard compression cylinders, samples being taken at intervals of 200 ft. along the sewer. All cement used was tested at the point of manufacture.

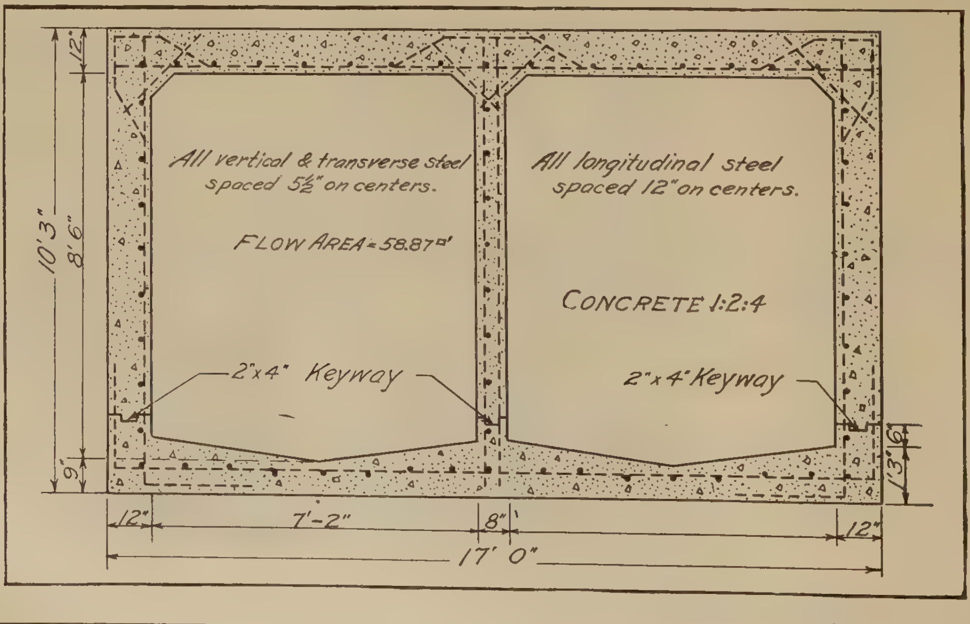
An idea of the magnitude of the entire project may be gained from the quantities involved. Approximately 225,000 cubic yards of concrete and 1800 tons of reinforcing steel were used.

The west end of the box sewer, showing open cut construction adjacent to the concrete pavement slab

◆ ◆ ◆

Typical section of the Nine Mile Halfway double box drain

◆ ◆ ◆


12"
10'3"
8'6"
9"
All vertical & transverse steel spaced 5½" on centers.
FLOW AREA = 58.87□'
2"x4" Keyway
All longitudinal steel spaced 12" on centers.
CONCRETE 1:2:4
2"x4" Keyway
6"
1'3"
12"
7'-2"
8"
12"
17' 0"

Construction Methods Varied

Both open cut and tunnel construction were employed in building the drain, the choice being based upon the conditions existing along the route. The minimum grade of the sewer was .06 per cent and the maximum .10 per cent with a total fall of 54 ft. between the surface of the ground at the upper end and the level of the lake at the outlet, a total length of 41,500 ft.

The area drained is a residential territory situated on the outskirts of the city of Detroit, and has a present population of approximately 15,000 people. Parts of this territory have improvements such as water and gas supplies and these utilities are rapidly being supplied to the remaining sections. The large amount of pavement being installed is greatly increasing the run-off in this district to be cared for by this drain. The district is narrrow, having a maximum width of two miles and being much narrower at the lower end.

The traveling steel forms used by the contractors in open cut construction

At the end of the box sewer described is a diversion chamber at which point the dry weather flow is diverted to a disposal plant located one half mile north of the main sewer. The upper end of this diversion chamber is connected to a monolithic concrete cylinder 11 ft. in diameter. The size of the drain varies to a minimum circular section 7 ft. 6 in. in diameter at its upper end.

Project Divided Into Six Sections

To speed up construction and insure completion of the entire project at as early a date as possible, the work was divided into six sections for contract, the smallest of which amounted to $285,000. The total of the contracts for the entire project approximated $2,454,000.

Numerous different conditions were encountered throughout the drain project and different methods of construction were employed. For a considerable distance the sewer was built along a paved highway which could not be closed to traffic because it was the only available east and west highway for heavy traffic in a belt several miles wide.

In a number of places buildings had been built within 24 ft. of the edge of the existing pavement, leaving only that width available for the construction of the sewer.

The lower end of the sewer was constructed entirely in open cut to a point where the cover was more than 12 ft. about 3½ miles from the outlet into the lake. From this point all work was done in tunnel, thus eliminating considerable inconvenience to the traveling public and to business places located along the highway.

The soil encountered consisted of good clay all along the route with the exception of a half mile stretch in the vicinity of Gratiot Avenue where a vein of quicksand was encountered. This necessitated the use of compressed air in tunnel operations, and with only 22 ft. of cover over the tunnel through sand, considerable difficulty was experienced in holding the air pressure high enough to stop the inflow of water and at the same time preventing the air from blowing through.

A bank building and several stores were nearly directly over the route of the sewer near the Gratiot Avenue intersection, making this work more hazardous.

On the four contracts which make up the main sewer including the outflow section, different methods for handling the concreting materials were employed. The sand and gravel used were all obtained from Oxford pits, shipped to nearby railway sidings and trucked to the jobs.

The use of bank-run materials was not permitted by the specifications. The coarse aggregate used was 2½ in. and under.

On section "A" at the lower end, which included 4,366 ft. of 7 ft. 6 in. by 8 ft. 6 in. double box and 800 ft. of 7 ft. 2 in. by 8 ft. 6 in. section, the materials were de-

Placing the invert in the open cut for the 11-ft.-cylinder, without forms livered to a point centrally located at the Jefferson Avenue intersection and shoveled by hand into trucks holding two batches each. The proportions were measured in wheelbarrow loads. A paving mixer mounted on caterpillar treads traveled along the side of the open cut and discharged directly into the forms. The required water was pumped from wells along the line. Cement was delivered by truck from Detroit.

In building up the double box section, concrete for the invert was placed first with its reinforcing steel and with the steel rods for the vertical walls in place. The vertical walls were built up 6 in. above the invert. After the concrete in the invert had hardened sufficiently, Blaw-Knox collapsible steel forms for the inner wall and for the under side of the roof slab, were mounted in place with the aid of a traveler running on a narrow gauge track laid on the finished invert. Forms for the outer wall faces were built of wood and made in sections that could be handled readily and moved ahead for reuse.

An 80 ft. section of forms was placed at one time with a temporary bulkhead to hold the concrete at the forward end and to form a keyed joint with the next section poured. Thus the concrete was placed in sections of 80 linear ft.

The double box section required about 2 cu. yds. of concrete and 200 lbs. of reinforcing steel per linear ft. An 80 ft. section was poured in a ten-hour day.

As soon as the concrete was ready for curing it was ponded and kept moist until back-filling was completed.

The method employed in building the 5,792 ft. of 7 ft. 6 in. by 8 ft. 6 in. double box section which made up contract "B" was similar to that used on the contract "A." Identical forms were used and the same length of section of sewer placed at one time. Overhead bins were erected at a strategically selected point located near the center of this section and the aggregates were hoisted by a crane into the bins and were discharged directly into trucks as needed for transportation to the mixer. Each truck load consisted of two batches for the mixer.

The aggregates for contract "C" were delivered by truck along the path of the sewer and moved by hand in wheelbarrows to the mixer for the open cut work. The contract included 5,618 ft. of open cut and 3,375 ft. of tunnel construction in sizes ranging from 10 ft. 9 in. to 11 ft. cylinder.

Contract "D," covering the upper end of the drain, was constructed entirely in tunnel. This was cylindrical in section, the diameters ranging from 7 ft. 6 in. to 10 ft. 3 in.

Cylinder in Open Cut

In the construction of the cylindrical section in open cut the earth in the bottom of the excavation, which was a firm clay, was trimmed to conform with the outer lines of the invert. Concrete of a rather dry mix was chuted directly to the bottom of the excavation and hand placed to the proper alignment and thickness of wall. Templets were used in finishing the inner surface of the invert. Short lengths of steel bars were embedded part way in the invert to serve as dowel bars to strengthen the joint between the invert and upper section of the sewer wall.

After the completion of a section of the invert, sectional steel forms were built up for the inside of the sewer and for the outside as required, the outer forms being placed in longitudinal sections just in advance of concreting operations so as to allow for properly placing and tamping the concrete.

In the tunnel construction, work progressed each way from the shafts. Excavated material was transported in small cars to the shaft and hoisted to the surface. Concreting followed immediately after excavation in each section.

The inner steel forms were put together in sections as the excavation advanced. Concreting was started at the bottom sections of the forms and as this work progressed, the form sections were placed one above the other and the concreting of a section of cylindrical ring continued up to the key section of the forms. After the last or key section of the forms had been placed, it was necessary for a workman to shovel the concrete into the space above the inner form, from the forward end, and to force it back, thus completing the monolithic ring section. Where different sizes of cylindrical section were included in one contract, forms were used to fit the different diameters. Cylinders 7 ft. 6 in. to 10 ft. 3 in. in diameter were made with 12 in. monolithic concrete walls and the 10 ft. 6 in. to 11 ft. cylinder walls were of monolithic concrete 16 in. thick.

Erecting forms for the 10 ft. 9 in. cylinder in the tunnel

The contractor on the particular section of the drain passing under Harper Avenue where the early strength concrete was required, was A. J. O. Sullivan of Port Huron, who rendered excellent co-operation in the working out of a suitable mix for the early strength concrete.

Other contractors who successfully completed sections of the drain were: Walbridge-Aldinger Company, Steve Fattore, Culbertson and Kelly, and C. A. Handeyside Construction Company, all local Detroit contractors.

The plans and specifications for the complete project were prepared by Walter Lehner, Macomb County Engineer. Head, Decker, Shoecraft and Drury were consulting engineers on the disposal plant. Edward D. Miller is drain commissioner of Macomb County. The information contained in the above article was furnished by Paul Benz, of the engineer's office, to whom acknowledgment is made for co-operation in getting details of the construction methods.

Decorating Concrete

Some Practical Instructions for the Decoration of Concrete in Polychrome Effects — Preliminary Coats — Applying the Color—Recommended Pigments

By MAXIMILIAN TOCH, D. Sc., F. C. S.

THE painting of concrete was satisfactorily accomplished as far back as 25 years, and the principle involved was, replacing linseed oil paint, which saponified and became mushy when in contact with wet concrete, with a high acid vehicle filler or paint which combined with the lime.

Within the last few years, however, a demand has sprung up for the decoration of concrete in fantastic polychrome effects, and this type of decoration demands a treatment somewhat different from that of ordinary floors and walls.

To understand the effect of using the proper materials one must be acquainted with the physical and chemical constitution of portland cement. When portland cement is cast, puddled and trowelled, and the forms removed, the surface may take the imprint of the boards, after which it is generally porous and uneven. Sometimes it is desired to leave ceiling beams and columns in this condition so as to simulate age and older fashions, and in buildings of that type, owing to the difference in structural composition as compared with a finished floor, it is necessary to treat the concrete so that the fine colors used will not peel, decompose or disintegrate.

How to Paint Concrete

The first procedure is to apply a wash of sulphate of zinc, four pounds to the gallon. This, however, does not have the desired result in every case, because a concentrated solution of zinc sulphate, if there should be any moisture, may become hydroscopic depending upon the moisture or dryness back of the concrete, and this may cause peeling or disintegration of the decoration. It is therefore wiser to use a fluo-silicate of magnesium and zinc, and can be used in a much more dilute solution of one pound of the dry crystals to the gallon of water.

As soon as this has sufficiently dried so that no more moisture is apparent, it must be dry-brushed so as to remove any slight crystallization which may appear on the surface, because it is never wise to paint on a crystalline surface.

The concrete is then filled with an acid resin filler, not of the spar varnish type, as the general run of spar varnishes are too neutral, but of the cement filler type which are distinctly organic acid. One coat, which has been thinned with about one-third of turpentine, is sufficient, and this usually soaks in and gives an excellent surface on which to paint.

The next procedure is to select the proper type of colors and to determine whether they should dry with a gloss or whether they should dry flat. In case the colors should dry flat, oil colors are taken which are alkali-proof and which are listed below, and thinned with turpentine only. In case a glossy effect is desired, oil colors are taken and thinned with cement filler.

Greens:

Average greens that can be purchased from paint manufacturers are mixtures of chrome yellow and prussian blue. Neither of these two are alkali-proof and the green made with these two primary pigments should not be used. There are two other greens that are absolutely permanent and that have been used for centuries. One of them is known as chromium oxide, opaque, and the other chromium oxide, hydrated, the latter being one of the most beautiful greens in existence and unalterable under any circumstances.

Yellows:

Chrome yellow is very unsatisfactory, as it is likely to turn brown. Furthermore, it is not light-proof. The yellows that can be used successfully are ochre, raw sienna, lemon cadmium, golden cadmium and orange cadmium.

Reds:

Pure ferric oxide of the Venetian red and Indian red type are perfectly safe to use. Madder lake as a glaze is alkali-proof, and toluidine toner, known as fire red, is also alkali-proof. This will give a sufficient range of reds for all purposes. For vermillion, the toluidine vermillion which is precipitated on orange mineral, is brilliant and permanent.

Blues:

There are only two blues which are safe to use, which are permanent to light and permanent to alkali. Both are artificial. One is known as cobalt and the other is known as ultramarine blue.

Blacks:

Ivory black, carbon black, lamp black, and graphite, are perfectly safe and can be used for all concrete painting purposes.

White:

For white, perhaps the safest is light-proof lithopone, because that is a sulphide color which goes very well with the cadmiums and with greens. Flake white (white lead) must never be used, because it is acted upon by the sulphur fumes of the air, but zinc white is reliable and permanent. The new titanium whites have excellent hiding power and are also safe to use on concrete. You therefore have three whites—lithopone, zinc white and titanium white—which can be indiscriminately used.

Brown:

Umbers and siennas and a mixture of Indian red and black, give a variety of browns that are reliable and safe.

Violet:

Cobalt violet is perfectly safe but is expensive, but other violets can be made by mixing white, madder lake and cobalt blue.

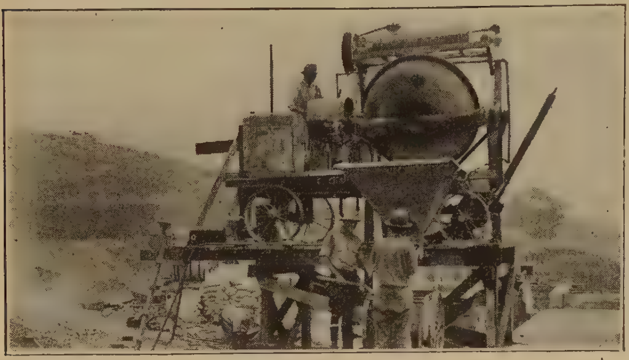
Emerald green can be produced by using the hydrated chromium oxide reduced with white, to which a very small amount of cadmium yellow is added. Emerald green, which is Paris green (arsenite of copper) is a very unstable color unless it is varnished over within 24 hours with an impervious varnish of the cement filler type. It is safer, however, to use the chromium hydroxide tinted with white and yellow.

New Device for Sampling Concrete Used on Los Angeles County Bridge Construction

By **WM. D. ARMSTRONG**
Bridge Engineer, Los Angeles County Road Department,
Los Angeles, Calif.

In the construction of the Eastern Avenue overhead viaduct on the San Bernardino branch of the Pacific Electric Railway under the supervision of the Los Angeles County Road Department, a new sampler mold recently developed by C. S. Howe, engineer for the Los Angeles Testing Laboratory, was used with good results.

Routine compression tests of concrete are made on all county bridge projects, and it is thought that the new mold used for casting the specimens on this work is a decided advance over methods formerly used. A very advantageous feature is the provision of a base and carrier so that specimens may be moved from the point of casting immediately.



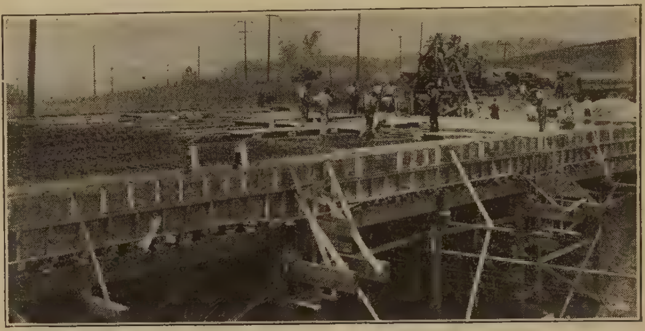
Close-up of the mixer, which discharged directly into buggies

Construction was started on this project March 1st by Byerts and Dunn, contractors. The viaduct is 105 ft. long, 83 feet wide, with a 60-ft. roadway and 10-ft. sidewalks. It is a five-pier girder span, reinforced concrete with precast rail. Its construction required approximately 749 cu. yds. class "A" concrete, 17.4 cu. yds. class "C" concrete, 100,000 lbs. of reinforcing steel, 25,530 sq. ft. of forms and 744 cu. yds. excavation. The contract price was approximately $25,000.

Test specimens were made at the mixer in the new type mold which is made of resilient sheet steel sufficiently strong to resist deformation when the mixture is puddled. It is open at both ends and has a special sliding form at the vertical aperture which both closes the form and locks it while the specimen is being cast. The spring in the steel cylinder releases the specimen when the slide lock device is withdrawn. It is further provided with a metal base plate of U shape in the vertical sides of which are holes for a heavy wire carrier.

Transporting the new testing cylinder described

Before the use of this type mold the casting was restricted to the use of paper cylinders and sealed tins. Recent comparative tests have shown that concrete cast in the two types of cylinders are not comparable, probably due to loss of water from the paper cylinder or from the bottom or by absorption. Tests of this metal cylinder, made by the Los Angeles Testing Laboratory, show the following:



General construction view of the bridge slab

	"Slide Lock Mold"	Tinned Sheet Metal Form Sealed Bottom	Paraffined Paper Form
Age of Cylinders	28 days	28 days	28 days
Mix by Weight	1:1.95:3	1:1.95:3	1:1.95:3
Nominal Size of Cylinders	6x12 in.	6x12 in.	6x12 in.
Slump, In.	7¾	7¾	7¾
Water-Cement Ratio	.98	.98	.98
Compressive Strength, Lbs. per Sq. In.	3347	3282	2816
	3247	3162	2999
	3200	3439	3179
Average	3264	3294	2998
Slump, In.	1¾	1¾	1¾
Water-Cement Ratio	.79	.79	.79
Compressive Strength, Lbs. per Sq. In.	4567	4790	4717
	5045	5144	5128
	4914	4565	4443
Average	4842	4833	4762
Ratio of Compressive Strength			
w/c — .98	.991	1.000	.910
w/c — .79	1.001	1.000	.985

On the Eastern Avenue viaduct, the cylinders were cast at the mixer from samples of concrete taken directly from the buggy under the spout. They were made after A. S. T. M. specifications. Immediately after casting, the cylinders were removed out of the way to a site where they could be undisturbed. The metal base and carrier proved effective in handling the specimens from the work as the whole mold and all can be carried in one hand.

After the test specimens has set it is placed in a barrel of water for the curing period, then sent to the laboratory for test. The mold is usable over and over and with care in oiling becomes a permanent fixture of the inspector's equipment.

The Eastern Avenue viaduct was designed and constructed under the writer's supervision. Harold F. Pope is resident engineer. George W. Jones is road commissioner of Los Angeles County.

The Concrete Manhole and Catch Basin Block Industry

A Worth While Market—Only a Few Products Manufacturers Have Developed It—Analyze the Market—Sales Arguments for Concrete Manhole Block—Savings to Sewer Contractors — Costs — Types of Manholes and Basins— How They Are Built—How the Block Are Made

By T. A. DAY

IN recent years the concrete manhole and catch basin block industry has developed considerably in certain sections of the country, but in some respects its growth has been more like that of the famous "Topsy" who, it is said, "jus' growed up."

Although the market possibilities of manhole and catch basin block are practically unlimited, indications are that the development of a nation-wide market for the units has been comparatively slow. That is, while some few manufacturers have taken advantage of the ever-increasing amount of sewer work in their respective communities by making and aggressively merchandising radial concrete units, other potential producers have overlooked this promising field for products. As a result, a large volume of concrete products business has slipped away from them.

The concrete manhole block industry, it seems, needs more manufacturers like the Stone, Brick and Block Works of Chicago; the Midwest Concrete Pipe Company of North Manchester, Indiana, and Franklin Park, Illinois; the Elmhurst-Chicago Stone Company of Elmhust, Illinois; Julius Sorenson and Sons of Racine, Wisconsin, and the Spencer Cement Block Works of Spencer, Iowa. They are among the leaders in this business. Some of them produce upwards of 500,000 units annually!

There is another leader in the Chicago territory that warrants mention—the William E. Dee Company. And, strange as it may seem, this company is one of the leading distributors of clay products in the Middle West; yet it does a big concrete catch basin block business every year.

Developing a Market

The development of a good market for manhole block depends, in a measure, on the amount of sewer work that is in prospect for any one community. Estimating that the average manhole has an inside diameter of 48 inches and that the depth of the masonry is 10 feet, each manhole in a sewer system will require 142 block. With one such structure located every 300 feet in a sewer system, that means at least 2,400 block per mile of sewer. In addition, if curb catch basins and basins at intersections of streets are built, at least 3,000 more concrete units will be required. In other words, when manufacturers overlook the concrete manhole and catch basin block business, they are passing up a market for at least 2,400 concrete units for every mile of new sewer that is built in their community.

Not so the six manufacturers mentioned previously. Their representatives keep in touch with every sewer project, large or small, that is within shipping distance of their plants. They get out and merchandise the block. The first step toward this end is, of course, to convince the engineers on the job that concrete block are superior to other materials for sewer appurtenance construction.

These advantages are summed up in the following paragraphs:

The units are truly circular, rigidly interlocking, resistive to corrosion and watertight. When laid up to form circular manholes or catch basins, the block provide water-tight walls which increase in strength with age. That is, the damp earth or soil provides a natural curing condition for the concrete. Too, the block are inherently strong. According to the American Concrete Institute specifications, by which manufacturers are guided, "The ultimate compressive strength of solid concrete manhole and catch basin block at 28 days or when delivered upon construction work shall average not less than 1,500 lb. per sq. in. of cross-sectional area of the unit as laid in the wall. No individual unit shall test less than 1,200 lb. per sq. in. of cross-sectional area under the same conditions." Furthermore, "Concrete manhole and catch basin block shall not absorb more than 8 per cent of the dry weight of the unit when tested as hereinafter specified. No individual unit shall absorb more than 10 per cent of the dry weight of the unit."

Illustration of a concrete block manhole of the 36-inch size. The units for this structure were furnished by the Stone, Brick & Block Works

After convincing engineers that concrete block should be placed at least on an alternate basis with other materials, the next step is to get sewer contractors enthused about the product. In most cases, contractors can effect a saving of between 50 and 60 per cent in labor and between 60 and 80 per cent in mortar. The fact that this saving is possible is in itself a good sales argument for the product.

It is a simple matter to demonstrate this to contractors. One of Chicago's leading producers of manhole block makes it a point to keep in close touch with all sewer builders. When he finds one that is not familiar with radial concrete units, he offers to supply, free of charge, enough block for one standard manhole or catch basin, as the case may be. Then, co-operating with the contractor, he superintends construction of the block structure, keeping accurate costs on every item of labor and material. Following this, he asks the contractor to have a crew lay up a brick structure of the same size as the one built with concrete block. The cost figures usually compare with those given here, where it is estimated that a crew consisting of one bricklayer and two common laborers can build a brick structure in 12 hours and a concrete block structure in 4 hours, roughly a saving of 60 per cent in labor.

Costs

Cost of Masonry in 48-Inch Manhole, 10 Feet Deep

Concrete Block (142)		Common Brick (1,800)
$35.00	Materials	$27.00
12.00	Labor	36.00
4.00	Mortar	10.00
$51.50	Total	$73.00

These costs are based on concrete block at 25 cents each; common brick at $15.00 per thousand, delivered (average of 21 cities); bricklayers' scale, $1.50 per hour (average of 21 cities); common laborers' scale, 75 cents per hour (average of 21 cities). Before discussing the manufacture of concrete manhole and catch basin block, it is best to consider briefly the nature of the structures for which they are designed and the requirements they are meeting so satisfactorily. They have been used for domestic catch basins, sewer manholes, and curb catch basins for storm sewers.

Domestic Catch Basins

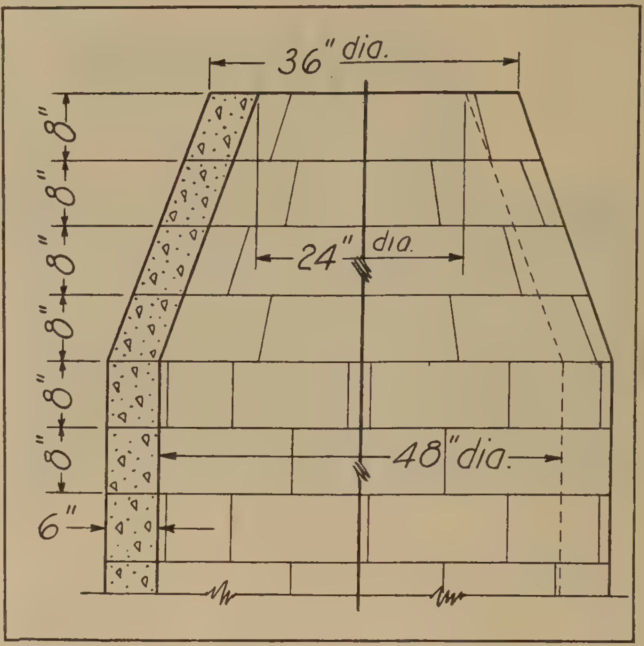
This type of structure is a circular well, usually placed in the rear of a dwelling. Its function is to trap the wastes from the kitchen sink and prevent this solid, greasy matter from entering the house drain and thence passing into the sewer system. This type of catch basin usually has an inside diameter of 30 or 36 inches and a depth of from 5 to 7 feet. If it is built of clay brick, the wall thickness is ordinarily specified as 8 or 9 inches. When monolithic concrete or concrete block construction is used, the wall thickness is 6 inches. In either case, this type is floored with an 8-inch concrete base. Circular concrete slabs, with an opening to take a standard cast iron cover, are used to close the tops of domestic catch basins. (Many plumbing codes require that each residence plumbing system be equipped with a domestic catch basin.)

Curb Catch Basins

These structures are similar in construction to domestic catch basins, although usually of somewhat larger diameter. The purpose of these basins is to catch the storm or surface water from the gutters before it enters the main sewer line, preventing the entrance of solid matter or floating debris. These basins are particularly desirable sewer appurtenances when the system is of the combined storm and sanitary type.

Sewer Manholes

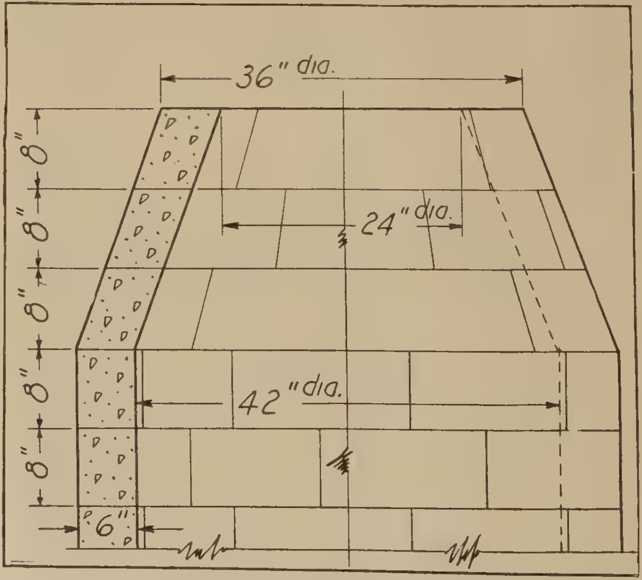
These sewer structures are usually designed with an inside diameter of 36, 42 or 48 inches, and sometimes larger, depending upon the size sewer pipe that is used. Manholes must, of course, be large enough to permit entrance of workmen who are inspecting or cleaning the sewers. Such structures vary in depth from 2 feet to 25 or 30 feet and, sometimes, they are deeper. It is standard practice to reduce the inside diameter at the top to 24 inches.



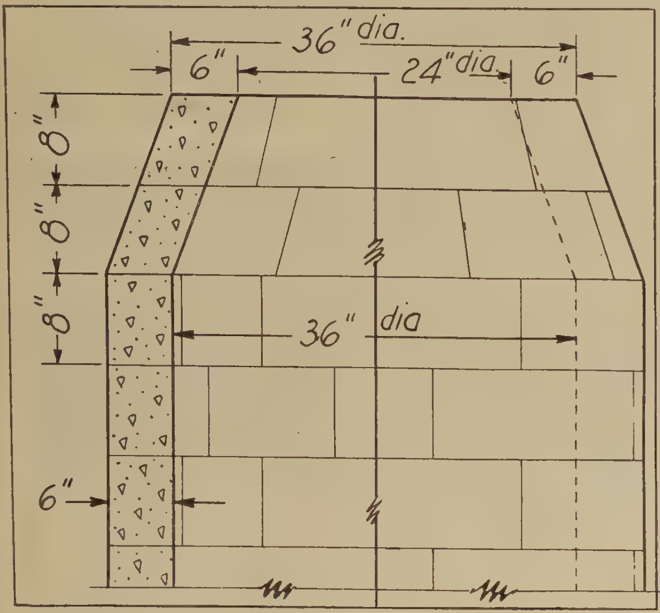
Showing a catch basin in half section and half elevation. Four courses of batter block complete the "cone" in this structure

Manufacturing Methods

The manufacture of concrete manhole or catch basin block is as simple as making any dry-tamped concrete

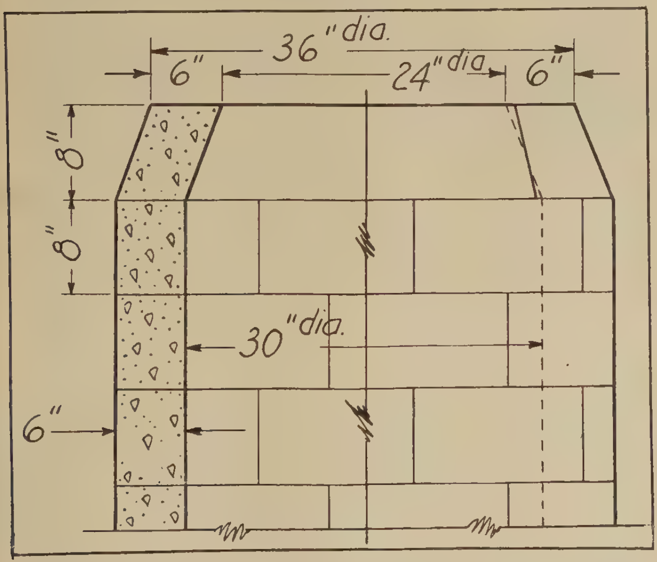


Concrete block sewer structure of 42-inch inside diameter shown in half section and half elevation. Three courses of batter block are needed for this size product. Ordinarily, producers find that machine production, using a stripper attachment under a power-tamper, gives the best results. One producer in Chicago operates only one tamper, but produces four different sized units almost at will. That is, he utilizes interchangeable mold boxes on his stripper machine and interchangeable tamper feet on his tamper. On the average, it requires one of his workmen only 30 minutes to change the mold box and tamper feet to make another size unit. He produces radial block having a radius of 30, 36, 42 or 48 inches.



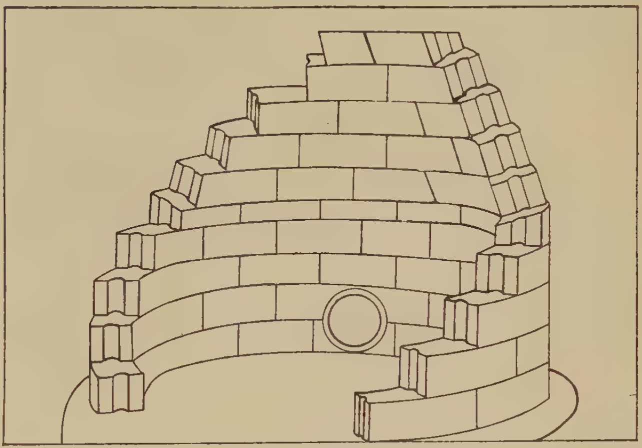
Thirty-six-inch concrete block manhole or catch basin shown in half section and half elevation. This size requires two courses of batter block

Concrete units designed for domestic catch basins, sewer manholes or curb catch basins have horizontal cross sections in the form of segments of a circle. It is recommended that block have a wall thickness of not less than 6 inches, while the height may be anything up to 7½ inches. On one end of each unit is a vertical groove and on the other end a corresponding tongue. Or, if engineers prefer double-groove block, the adjacent ends of which



Half section and half elevation of 30-inch concrete block manhole or catch basin. Only one course of batter block is required

Showing the finished walls of 36-inch concrete block manhole. This is known as the barrel part of the structure



A 48-inch concrete block sewer structure where one course of bevel block is used to start the "cone." One less unit of the same type as is used to build up the side walls is used in each succeeding ring of the "cone." Top course of the "cone" may be built of reverse bevel block, as shown, or of regular units and leveled up with cement mortar

Workman starting "cone" of 36-inch concrete block manhole. As shown, units are first laid in a full bed of cement mortar. Five more block complete the first course of "cone" form a core hole, this type can be made. When laid up, the units are rigidly interlocking and the finished structure possesses the strength and rigidity of monolithic concrete construction. When laying double-groove block, core holes are filled with cement grout. Individual barrel or wall units, as they are called, are so shaped that 7 of them are required for each course of a structure having a 30-inch inside diameter; 8 units, for 36-inch; 9 units, for 42-inch, and 10, for 48-inch. This makes all units of approximately the same size and weight (usually not over 50 pounds) which permits equally easy handling and laying.

Setting the Block

Specifications require "drawing in" or reducing the inside diameter of manholes or curb catch basins near the top to fit the circular frames for the removable cast iron covers. In brick construction this is accomplished by the tedious method of corbelling the courses of small units, but in concrete block construction it can be accomplished in one of two ways. One method is to use batter block. One course of batter block (8 hand-made units) reduces a 30-inch structure to 24 inches inside diameter at the top. Two courses are required to reduce a 36-inch structure to 24 inches; 3 courses to reduce a 42-inch structure to 24 inches, and 4 courses to reduce a 48-inch structure to 24 inches. (Accompanying drawings illustrate the method of drawing in the four different sized structures.)

In the other method used to reduce the inside diameter of sewer structures at the top, one course of bevel-block is used to start the cone, as it is called. Then, one less unit is used in each succeeding course until the required inside diameter is reached.

Either method of "drawing in" is practical. However, the use of batter block insures a smoother structure inside as well as outside. But, on the other hand, no hand-made units are required if the bevel-block and succeeding courses of barrel block, as illustrated, are used.

At the time of manufacture, units designed for various sized structures are marked by numerals raised on the pallets or by other convenient means. Batter block are usually marked with various colored paints, easily distinguished, preventing any confusion on the actual construction work.

Special block designed to form openings in manhole or catch basin walls to receive intake and outlet pipes, conduits, and so forth, are usually provided to speed up construction. However, these openings, as well as irregular breaks and "runarounds" frequently encountered in the underground lanes of pipes and conduits, are easily made by cutting the block as required.

July, 1928, Excells All Previous Construction Records for That Month

The Associated General Contractors of America, in their monthly report on volume of construction, state that more than $4,000,000,000 have been expended for construction operations of all types in the United States since the opening of this year. The figures, based on actual shipments of construction materials, show the volume of operations carried on during the first seven months of this year to be three per cent greater than the total recorded for the corresponding period of 1927.

The volume of work handled during July was the greatest ever recorded for that month of the year. It was July's large volume, following the record-breaking June activities, that enabled the total for seven months to reach the high position it occupies.

July construction contracts in the territory east of the Rocky Mountains reached a total of $583,432,400, according to F. W. Dodge Corporation. The area covered in this record consists of 37 states and includes about 91 per cent of the total country. The above figure was the highest July contract total on record. It was 9 per cent ahead of the total for the same month of last year, but there was a drop of 10 per cent from the total for June of this year.

July witnessed a slight decline from the lofty June level, according to the A. G. C. Despite the drop, however, last month held a position topped by only August, 1927, and June of this year.

The large volume of contracts recently awarded indicates that the present rapid pace held by construction activities will be continued for several weeks to come, it is stated.

Last month's record brought the total amount of new building and engineering work started since the first of this year up to $4,028,299,900, establishing a new high record for new construction contracted for during the first seven months. The increase over the first seven months of 1927 was 8 per cent, the Dodge Corporation reports.

Analysis of the July building record showed the following outstanding items: $228,734,800, or 39 per cent of the total, for residential construction; $137,074,700, or 23 per cent, for public works and utilities; $95,696,800, or 16 per cent, for commercial buildings; $36,926,400, or 6 per cent, for educational projects; and $31,399,800, or 5 per cent, for industrial projects.

New work contemplated in the 37 states during the past month reached a total of $647,682,700, being a loss of 37 per cent from the amount reported in the preceding month and a drop of 7 per cent from the amount reported in July of last year.

Program for Construction Section of Safety Group

The construction section of the National Safety Council will convene at a luncheon on October 1st as a part of the seventeenth annual safety congress, to be held at the Pennsylvania Hotel, October 1st to 5th.

Walter S. Fraddis, president of the Building Trades Employers' Association of the City of New York, is to deliver the address of welcome to the construction section. There will follow talks by R. H. Shreve, president of the New York Building Congress, John Sullivan, president of the New York State Federation of Labor, and Jas. A. Hamilton, industrial commissioner, New York State Dept. of Labor.

On the following morning, there will be reports of the various committees, after which there will be addresses by H. W. Lohmann, Chairman, Committee of Accident Prevention, Building Trades Employers Association, New York City; on "Safety By New York Contractors"; F. H. Westmeyer, of A. Bentley & Sons Co., Toledo, on "Educating for Safety On the Job"; Dr. S. W. Grafflin, of the West Side Y. M. C. A., N. Y. City, on "First Things First" and C. A. Walters, Secretary, Dept. of Labor & Industry, Harrisburg, Pa., on "Safety and the State."

Election of officers will take place on Wednesday morning after which D. F. McMurchy, Structural Engineer, Industrial Commission of Ohio, Columbus, will talk about "Wire Rope and Safety" and there will be a round table discussion on "How I Would Start a Safety Program."

Practical Kinks from the Job

Caterpillar Tractor Pulls Metal Form from Concrete Tower Foundation

When the Commonwealth Edison Company, of Chicago, built concrete piers to serve as foundations for the steel towers of a 132,000-volt line, they found an unusual use for a caterpillar tractor. The sections of the form, weighing 1170 pounds, were so constructed that they might be used over and over again—the caterpillar dragging them from place to place as shown in the first illustration, After the concrete had been poured and had set, the same tractor pulled out the form, as shown in the second illustration.

A Field Test of Sand

By MICHAEL J. PHILLIPS

An effective field test for sand was evolved by Harvey W. Hincks, engineer in charge of construction on the civic center project in Pasadena, California. Specifications for all sand used in the mixing of concrete required that not to exceed 3 per cent silt by volume shall be contained in the sand.

The silt test was made by the decantation process. A can containing 100 cubic centimeters of sand was taken from a truck as it drove in with its load. It was poured into a shallow pan, and about 500 cc. of water was poured over the sand, which was thoroughly washed with the hands for 15 seconds.

The specimen then stood for 15 seconds to allow the sand to settle. The water with the suspended silt was poured into a graduated cylinder of 2000 cc. capacity. The process of washing the sand was continued until the water became clear.

Observation was made of the amount of silt that settled in two hours. From experiments it was found to be 160 per cent of the settlement that occurred in 24 hours. For instance, if a reading of 6 cc. of silt was had in 2 hours, a settlement of 3.7 cc. would be expected in 24 hours.

If it was desired to get a more accurate reading of the amount of silt, nearly all the water was poured from the top of the deposit of silt. What remained was mixed with a small amount of water and transferred to a graduate of 100 cc., which magnified the deposit of silt 10 times that observed in the larger graduate.

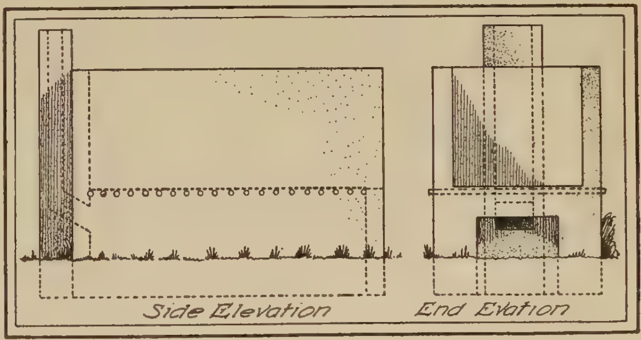
If the sand in a consignment looked at all dirty, the sample was taken, and in two hours there was definite knowledge whether the sand came up to specifications. This prevented the delivery of a poor grade of sand in any large quantity to the bunkers.

Heating Sand in Cold Weather

The contractor in charge of a four-floor apartment house job built a good sand heater right on the job. It is not portable, but the cost was very small, compared with its actual advantages. The idea is shown in the accompanying sketch. No dimensions are given for these will probably vary with every case. The best average size is four feet wide, four feet high and six feet long.

Forms for four-inch walls were set up and small gas pipes run through from one side to the other at the 18-inch level. The walls, of course, extend down into the ground a little way.

At the back end a flue with an inside size of three by six inches took care of the smoke. This extended a few inches above the top of the walls. After the cement had cured for ten days, sheet iron was laid over the pipes and the sand shoveled into this hopper, while a fire underneath quickly heated it. The wide open end over the mouth of the fire box facilitated shoveling the hot sand out again.



There is a distinct advantage of using hot sand. It warms the water and cement to a moderate temperature and then when the concrete is protected against cold weather, there is but little danger of freezing.

This sand heater was built as soon as the contractor moved into the job. By the time the concrete work was ready, the concrete had cured sufficiently to enable the men to use it.

From the Products Associations' Bulletins

Northwest Concrete Products Association

F. R. ZAUGG, Secretary

THE August issue of "The Pre-Cast Product," as the association's bulletin is entitled, starts off to tell just what was missed by those who failed to attend its midsummer meeting at Rainier National Park on July 16th and 17th. Approximately 100 persons attended.

The bulletin, in its report of the meeting, tells of the value of W. D. M. Allan's "Concrete Products Manufacturer's Merchandising Conference" which was "put over so clearly and forcefully that the listeners called for more even after 3½ hours of continual listening."

Announcement is made of the fact that at this meeting, also, "The Pre-Cast Product" was made the official bulletin of the association and as such is to be open to members who have views and ideas to discuss with their fellow men.

The Northwest clan, as "shot" at Rainier National Park

The Concrete Pipe Company of Seattle, the bulletin states, has just completed the furnishing of 1875 round concrete anchor block for the Chicago, Milwaukee, St. Paul and Pacific Railway. These are 2 and 3 inches thick and 20 and 30 inches in diameter and are used to anchor the guide lines supporting the overhead wiring on the electrified portion of the railroad.

Water-cement ratio specifications using not to exceed 6 gallons per sack of cement and slump from 3 to 8 inches, it continues, are used in making the anchors. They are reinforced with two sets of crossed grids placed near the upper surface of the block. A small hole in the center of the anchor allows the anchor rod to pass through, to which the wire is fastened. Approximately 800 more are on order and being completed.

Nebraska Concrete Products Association

ROGER MERRITT, Secretary

THE editor of the Nebraska association's letter to members, in the August issue, comments upon general economic conditions in the state. The sale of building materials, he says, recently began to take on added momentum over the past year or year and a half. During the latter period, he continues, concrete products manufacturers should have taken advantage of the slackening to promote and educate the building industry to the use of their products.

The building public will find the state products association in evidence at the state fair with an exhibit of a variety of concrete products, an item in the bulletin states. The names of all members in good standing are to be displayed. It is planned to have a paid representative present to explain in detail about the products and to distribute literature.

Iowa Concrete Products Association

R. L. GAVIN, Secretary-Treasurer

The "Concrete Products News" of this association under the August dateline is full of short items of interest to the products manufacturer. The first, entitled "The Fear of Increased Costs," is extracted from an article dealing with necessity of advertising in modern merchandising. Further on is found a heading, "Newspaper Story on Products Plant," in which the writer lauds an article published by a Sioux City newspaper describing one of the member plants in a promotional way.

Another paragraph deals with the annual rural fire losses, saying, "Nearly every form of fire prevention is advocated by the fire marshals, fire insurance companies and newspapers except the only sound advice conceivable; the construction of farm buildings of concrete building units, the material that will not burn. How anyone of intelligence can expect to reduce fire losses by advocating frame construction and other highly inflammable material for walls, floors and roof construction is beyond comprehension. More concrete on the farm is the important factor in reducing farm fire losses."

Wisconsin Concrete Products Assn.

JACK FRANKLIN, Secretary

Some paragraphs on pertinent subjects are included in the August issue of this association magazine publication known as the "Digest." One of these is entitled "Tests" and says, "If the tests of your products are not accurate, they hide the truth about your products. Material 'gets by' that is not up to the requirements of the building code. Rejections are caused which cost money and customers. Good will of builders is lost. Can you afford to take these chances?

"On the other hand, the use of good materials manufactured economically, according to requirements with modern machinery will instill confidence in your products and increase your customers, your sales, and your profits."

This publication reports that some Wisconsin block manufacturers are doing a good farm business and its cultivation by others is urged.

The July issue contained an item regarding the formation of the Wisconsin Cast Stone Association. Eleven members at present comprise the organization. At a meeting in Green Bay recently, R. W. Albrecht, president of the Plastic Products Company, Milwaukee, was elected president and Al Broker, president of the Badger Tile Company, Plymouth, was elected secretary-treasurer. Weekly meetings are held in Milwaukee, and in various parts of the state monthly.

Reinforced Concrete Design Simplified

Chart E—Web Reinforcing

By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

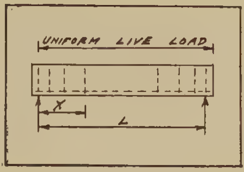
Joint Committee Specifications

$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$n = 15$

$$x = \frac{L(v - 40)/v}{2}$$

$$v = \frac{V}{bjd}, \text{ at end of beam.}$$

Allowable unit shear (v) without web reinforcing $= 40$ lbs. per sq. in.



AT the time of the original announcement of this series, Web Reinforcing was scheduled to follow Stirrup Spacing. Subsequent developments have demonstrated the advisability of interchanging these two.

The distance "x" from the support of a simple beam under uniform load defines the limit wherein web reinforcing must be provided.

In the July issue the unit shear was determined for a beam of simple span under a uniform live-load:

Span (L) $= 25$ ft.
Unit shear at end (v) $= 51.4$ lbs. per sq. in.

On Chart E an isopleth has been drawn between these values. At the intersection of the isopleth with the central scale a value ($x = 2.8$ ft.) will be noted. Substituting the values in the equation for this problem, we get

$$x = \frac{L(v - 40)/v}{2} = \frac{25(51.4 - 40)/51.4}{2} = 2.77 \text{ ft.}$$

The Joint Committee specifies:

"Web reinforcement may consist of:

(a) Vertical stirrups or web reinforcing bars;
(b) Inclined stirrups or web reinforcing bars forming an angle of 30 degrees or more with the longitudinal bars;
(c) Longitudinal bars bent up at an angle of 15 degrees or more with the direction of the longitudinal bars.

Stirrups or bent-up bars which are not anchored at both ends, . . . shall not be considered effective as web reinforcement. When the shearing stress is not greater than $0.06 f'_c$, the distance (s) measured in the direction of the axis between two successive stirrups, or between two successive points of bending up of bars, or from the point of bending of a bar to the edge of the support, shall not be greater than

$$s = \frac{45\,d}{\alpha + 10} \qquad \text{Eq. 1-E}$$

where the angle (α), between the web and longitudinal bar, is in degrees."

The specifications permit the use of either stirrups, bent-up bars, or a combination of both. Many building codes do not permit the use of bent-up longitudinal bars as web reinforcing, which is perhaps justifiable. The longitudinal bars are usually large in comparison to stirrup bars, thus concentrating a lot of steel in a given area. In contrast, stirrups give a much better distribution of steel. So the discussion of web reinforcing will be confined to stirrups.

When vertical stirrups are used the angle (α) becomes 90 degrees, limiting the maximum stirrup spacing, by Eq. 1-E, to

$$s = \frac{45\,d}{90 + 10} = 0.45\,d$$

In the March issue, under working stresses, the maximum shearing stress was given as $0.02\ f'_c$ without web reinforcing where the longitudinal bars did not have special anchorage. In the portion of the beam in which the shearing stress is less than $(0.02 \times 2{,}000) = 40$ lbs. per sq. in., web reinforcing is not required.

A simple beam under a uniformly distributed load must have adequate web reinforcing for a distance (x), Fig. 1-E, from the support.

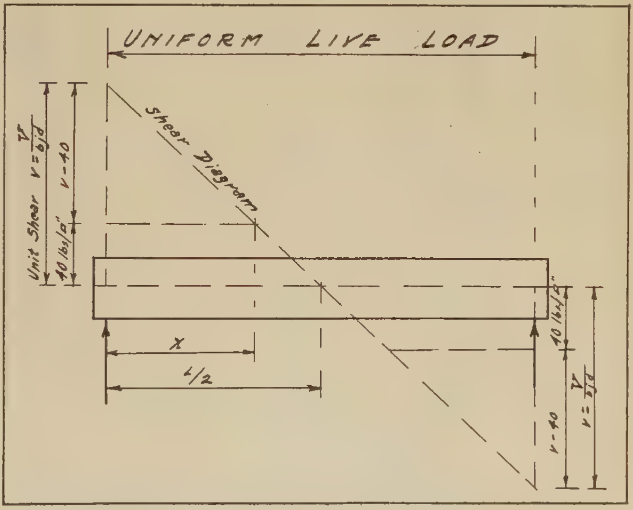
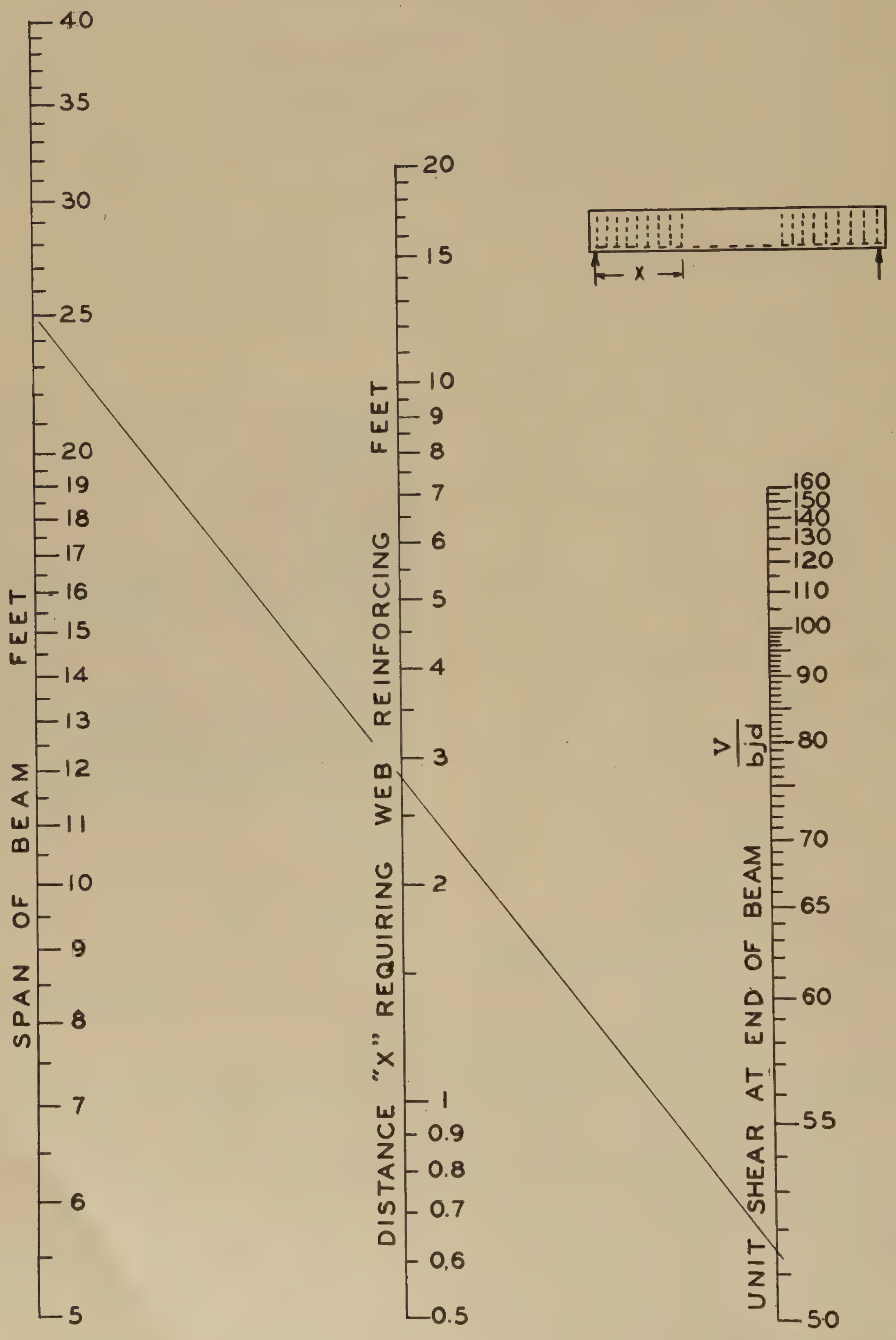


Figure 1-E

CHART E

Web Reinforcing for Simple Beams Under Uniform Loads
Allowable shear without web reinforcing = 40 lbs. per sq. in.



This chart is based on the Joint Committee specifications. Designers using the new American Concrete Institute specifications can design similar charts from instructions given in the March, 1928, installment and in this article

By similar triangles,

$$\frac{x}{L/2} = \frac{v-40}{v}$$

which can be written

$$x = \frac{L(v-40)/v}{2} \qquad \text{Eq. 2-E}$$

The portion of the beam requiring web reinforcing, for any other condition of loading, can likewise be determined from the shear diagram. Thus, in a simple beam under one concentrated load at the center of the span, the shear, Fig. 2-E, is uniform.

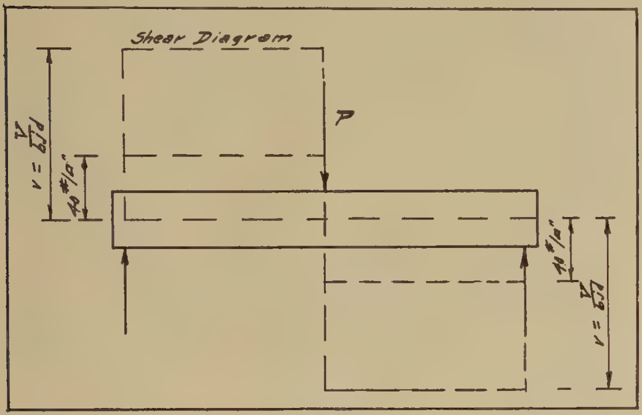


Figure 2-E

If the unit shear under such conditions is more than the allowable, web reinforcing must be used throughout the entire span.

Likewise, a beam of simple span with several concentrated loads, Fig. 3-E, may require web reinforcing in only a portion of the beam.

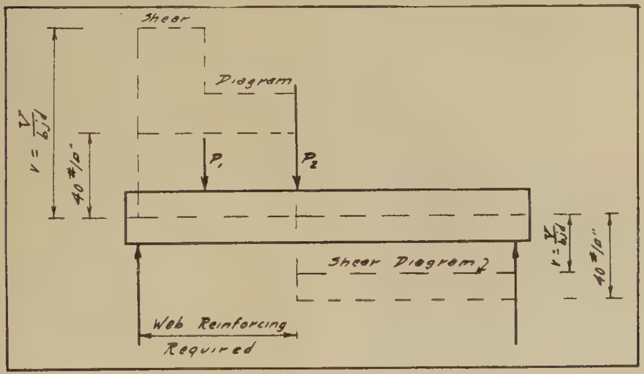


Figure 3-E

Construction of Chart E

Chart E has been designed to solve the expression

$$x = \frac{L(v-40)/v}{2} \qquad \text{Eq. 2-E}$$

If we let $y = \frac{v-40}{v}$

Eq. 2-E can then be written

$$x = \frac{Ly}{2}$$

which resembles general Eq. 7, March issue, requiring logarithmic co-ordinates. The actual exponents of both variables are unity and can be equated to the general exponents of Eq. 7.

$$\left.\begin{aligned} \frac{mn}{r} &= 1 \\ m(1-n) &= 1 \end{aligned}\right\}$$

Values of (L), the span, will appear on the left (L) scale, values of (y) on the right (R) scale, and values of (x) on the central (C) scale. Using the D-10 scale for both the (L) and (R) scales, the ratio (r) will become unity. Substituting the value $(r = 1)$ in the first of the last two expressions and solving them simultaneously for values of (m) and (n), we get

$$\left.\begin{aligned} m &= 2 \\ n &= \frac{1}{2} \end{aligned}\right\}$$

Thus the central scale must be half way between the two outer scales $(n = \frac{1}{2})$, and have co-ordinates one-half the size of those used on the right scale. This will require the use of the *A*-10 scale for the central scale.

While values of (y) are to be plotted on the right (R) scale, we are interested in only values of (v). So a table was prepared for values of (v) and their corresponding values of (y). Table 1-E shows a few of these values. Actually each point plotted on the right scale must be figured similar to the values in Table 1-E. At the various values of (y) the graduation was made and labeled its corresponding value of (v).

TABLE 1-E

v	$y = \frac{v-40}{v}$
50	0.2
60	0.333
70	0.428
80	0.50
90	0.556
100	0.60

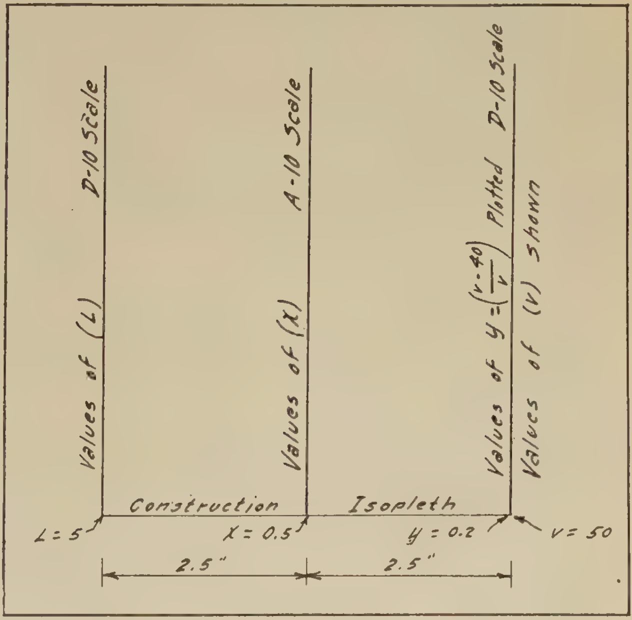


Figure 4-E

A construction isopleth was drawn at the bottom of Chart E for values of

$L = 5$ ft.

$y = 50$ lbs. per sq. in.

which, when substituted in Eq. 2-E, gives a value of

$$x = \frac{L(v - 40)/v}{2} = \frac{5(50 - 40)/50}{2} = 0.5 \text{ ft.}$$

This gives the central scale value at the construction isopleth.

While the assumed value for the right scale at the construction isopleth was $(v = 50)$, this is seen in Table 1-E to be the equivalent to a value of $(y = 0.2)$. In plotting the right scale, the log scale must then be laid down with the value (0.2) at the construction isopleth.

Fig. 4-E gives the complete details by which Chart E was constructed.

Select Leaders for Work on National Safety Rules

The American Engineering Standards Committee will invite the Association of Government Labor Officials of the United States and Canada and the Associated General Contractors of America to assume joint leadership in the establishment of national safety rules for the construction industries, the committee announces.

This action follows the decision of a general conference of representatives of all groups concerned with construction to recommend the establishment of national safety rules by the committee as a means of cutting down the great loss of life in the construction industries in every part of the country. Successful experience in establishing safety rules for other industries, notably electrical and mining, will be applied to construction.

The actual work of formulating the rules will be in the hands of a sectional committee on which all of the major groups concerned with construction and accident prevention will be represented. A group of 16 government, engineering and trade organizations will be requested to name official delegates to the sectional committee.

Reinforcing Institute Committees Hold Joint Meeting

A joint meeting of the committees on engineering practice and standard practice of the Concrete Reinforcing Steel Institute was held on July 12th at Chicago.

As the first step toward standardizing the information to be placed on metal tags attached to reinforcing bars, the committees witnessed a demonstration of the Pannier embossing machine. The value of a metal tag has been thoroughly demonstrated but the variance of information to be placed on the tag makes it necessary to manufacture these machines on special orders and the resultant cost is much higher than would be the case if the machines were made standard. It it thought that an agreement along this line will shortly be reached.

The two committees then reviewed the pending referendum of the U. S. Department of Commerce on forms standardization and listened to an analysis by H. D. Jolley, vice president and chief engineer of the Concrete Engineering Company, Omaha, in which certain features of this recommendation as relating to the taper of the end-forms were criticised. It is proposed to place a revised recommendation before the manufacturers of forms, so as to harmonize existing differences, and to pave the way for the adoption of the revised recommendation by all parties concerned.

At the conclusion of this joint session the committee met separately for the consideration of pending matters of immediate interest.

Fire Prevention Subject of Safety Congress Session

A general session devoted to fire prevention will be one of the features of the Seventeenth Annual Safety Congress at New York City from October 1st to 5th, inclusive. The chairman of the fire prevention session will be Rudolph P. Miller, consulting engineer, New York City, and the meeting will be held in the Pennsylvania Hotel on October 5th.

Franklin H. Wentworth, secretary-manager of the National Fire Protection Association, Boston, will speak about "Facts Written With Flames," after which there will be a discussion of the topic, "Organizing to Fight Plant Fires."

Recent developments in industrial fire prevention will be told by Harry E. Newell, of the National Board of Fire Underwriters, New York City, following which the election of officers for next year's meeting will take place.

Sherwood Brockwell, deputy and fire prevention expert, of the State Insurance Department, Raleigh, N. C., is scheduled to speak on the subject, "Keeping Fire Confined."

There will be no charge for admission and both members and non-members of the National Safety Council are invited to attend all sessions of the congress.

Pipe Manufacturers on Western Coast Meet

The second annual meeting of the California Associated Concrete Pipe Manufacturers is being held at the Hotel Casa Del Rey, Santa Cruz, California, from August 31st to September 3rd.

The program includes talks by Roy O. Fowler, Santa Cruz city engineer, on the Santa Cruz sewer system, by M. W. Loving, secretary of the American Concrete Pipe Association, on concrete pipe for sewers, by Chas. S. Pope, chief highway construction engineer for the California Highway Commission, on the highway construction program for the state, and addresses by Philip Schyler, managing editor of "Western Construction News," and by representatives of the Northwest Concrete Products Association and the American Concrete Pipe Association.

Coming Conventions

American Concrete Institute—February 12th to 14th, 1929. Twenty-fifth annual convention, at the Book-Cadillac Hotel, Detroit, Mich.

American Road Builders Association—January 14th to 19th, 1929. Convention and road show, at the Cleveland Public Auditorium, Cleveland, Ohio.

Concrete Reinforcing Steel Institute—October 1st to 3rd. Fall meeting, at Buckwood Inn, Shawnee-on-Delaware, Pa.

National Safety Council—October 1st to 5th Seventeenth annual safety congress, at the Pennsylvania Hotel, New York City.

Wear Tests of Concrete

Analysis of Tests Made to Determine Resistance to Wear of Concrete Used for One Course Pavement Construction—Study Effect on Wear of Variation in Hardness of Aggregates—Variation in Amount of Mixing Water—Use of Surface Hardeners, Substitution of Natural Cement for Portland Cement and Use of High Alumina Cement

By **HAROLD ALLEN**
Associate Professor of Applied Mechanics, Kansas State Agricultural College

IN 1921, Professor C. H. Scholer described a new method of testing the resistance to wear of concrete which had been developed by him in the Road Materials Laboratory of the Kansas State Agricultural College. The writer was assigned to work on further development of that test and this article is a review of the work done on concrete for use in one course pavements.

The test is made by molding the concrete into spheres 9 in. in diameter by means of a cast-iron mold. They are tested in a rattler used for the test of paving brick. The abrasive charge in the rattler is the same as for brick, that is, three hundred pounds of cast-iron shot. Three concrete spheres are used in each test.

The data presented were collected by running a series of tests to determine the resistance to wear of concrete made from a 1:2:3½ mix by dry and loose volumes. This mix was chosen because it is commonly used in the concrete for pavements especially in state highway work. The objects of the tests were to study the effect of a variation of the French Co-efficient of the coarse aggregate, the effect of the variation of the amount of mixing water, the effect of the use of a patent surface hardener, the effect of the replacement of portland cement with Fort Scott natural cement on the resistance to wear of concrete. Also to compare the resistance to wear of Lumnite cement (a quick-hardening early strength cement) concrete 48 hours old with that of portland cement concrete 28 days old.

The cements used in the tests were standard brands purchased on the open market and stored in air-tight cans. The stones used as coarse aggregates were furnished by the resident engineers of the Kansas Highway Commission or were local materials. Kansas and Blue River sands were used. The surface hardener used was a magnesium and zinc fluosilicate preparation furnished by the manufacturer.

Test Data Taken

Each specimen was made separately and all mixing was done by hand. The apparatus and molds used and a few test specimens are shown in Fig. 1. The necks are broken off of the specimens before the test is made. The following information was taken for each batch or sphere made:

1. Water used.
2. Consistency (slump or flow).
3. Weight of concrete in a known volume.
4. Sieve analyses of aggregates.

From this information, the fineness modulus, the water-cement ratio and cement required per cubic yard of con-

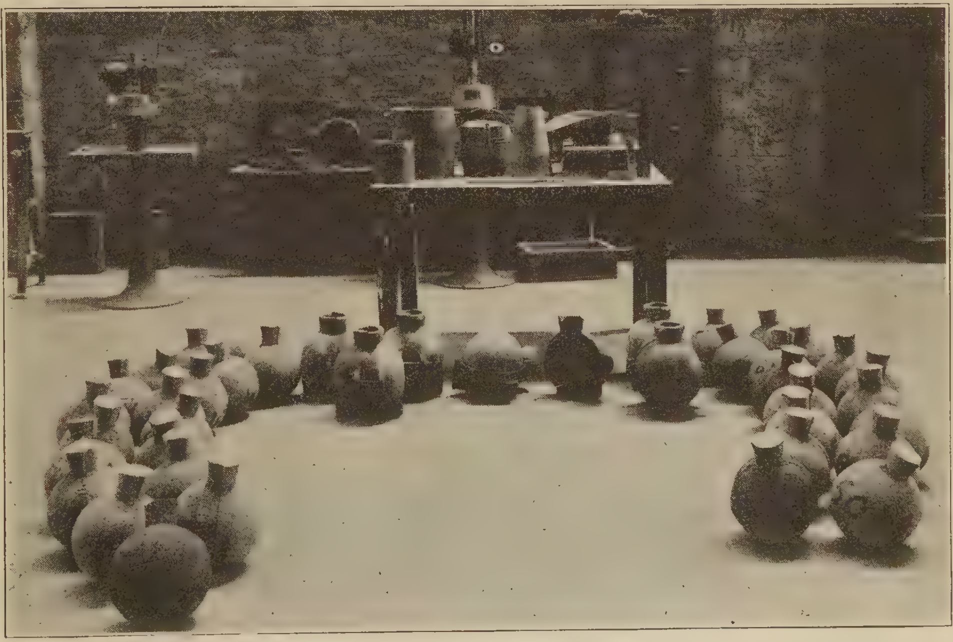


Fig. 1. Showing the apparatus and test specimens

crete were calculated.

In a part of the first series of tests, the compressive strength of the concrete was obtained from four and one-half inch cores drilled from the spheres after the abrasion test had been made. In all the succeeding tests except the surface hardener series, 6x12-inch cylinders were made for compression tests.

The wear in inches was computed from the loss in weight during the test as given in the following formula:

$$A = 4.5 - \frac{(91.125\ W)^{0.333}}{W_0}$$

in which

A = Wear in inches.
W = Weight of sphere after test.
W_0 = Original weight of sphere.

A curve of the above equation was plotted from which the wear in inches was read directly.

In most of the tests, the wear in inches per hundred revolutions was measured in order to provide data for plotting the wear in inches against the revolutions run. This method was valuable in comparing the results of the tests.

All specimens except those treated with surface hardener were cured in damp sand for 28 days and laboratory air for 32 days before testing. Both the treated and untreated specimens in the surface hardener series were air cured.

Discussion of Tests and Results

The method of testing the resistance to abrasion used in these tests was found to be entirely satisfactory and practical. The wear on all specimens except those of part of the consistency series was very uniform. In no concrete of good quality was the coarse aggregate torn out of the mortar. In all spheres except those made from stones having a French Co-efficient of 14 and 19, the mortar and the stone wore down together. The mortar wore away from the coarse aggregate in specimens in which those stones were used leaving the particles protruding. This is illustrated in Fig. 2. The sphere on the right was made from a soft, porous sandstone while the one on the left was made from a very hard, dense quartzite. This justifies the conclusion that very hard stone should not be used as coarse aggregate in concrete on which a smooth surface is to be maintained.

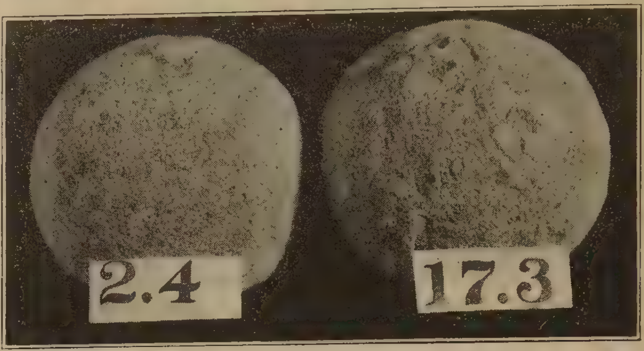


Fig. 2. The effect of the variation of the French Co-efficient of the coarse aggregate on the wear of concrete. The figures represent French Co-efficients

The surface of the spheres made of concrete in which an excessive amount of water was used were very rough

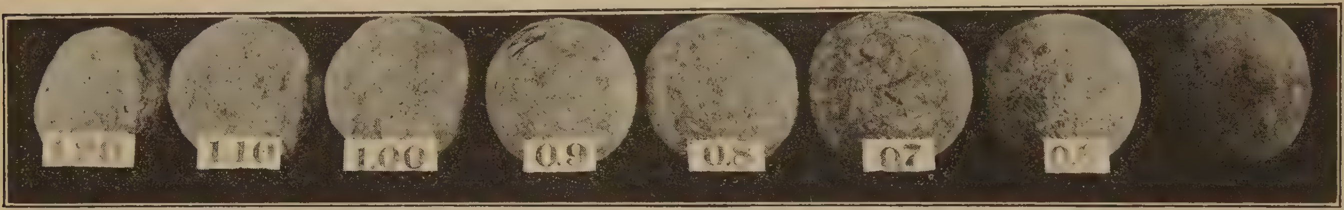


Fig. 3. The effect of the water content on the resistance to wear of concrete. The figures represent the water-cement ratios

TABLE 1

DATA ON CONCRETE IN WHICH KANSAS STONES OF VARYING FRENCH CO-EFFICIENTS WERE USED AS AGGREGATES

No. of Speci-mens	No.	French Co-efficient	Fineness Modulus of Mixed Aggregate	Water-Cement Ratio Cem. 1	Water-Cement Ratio Cem. 2	Slump in In. Cem. 1	Slump in In. Cem. 2	Inches of Wear Cem. 1	Inches of Wear Cem. 2	Compressive Strength, Lbs./Sq. In. Cem. 1	Compressive Strength, Lbs./Sq. In. Cem. 2
						SERIES 1					
3	4928	5.0	6.27	0.64	0.61	1.67	2.29	0.165	0.184	2970	2987
3	4929	7.2	6.23	0.64	0.63	1.67	2.25	0.132	0.145	3427	3113
3	4949	7.1	6.28	0.52	0.56	1.88	1.83	0.125	0.141	4010	3787
3	4950	5.2	6.24	0.63	0.61	1.92	2.04	0.145	0.168	3247	3117
3	4951	4.5	6.31	0.66	0.66	1.83	1.92	0.120	0.162	2797	3273
3	4952	4.5	6.29	0.50	0.45	1.75	1.50	0.159	0.150	3100	3477
3	4953	5.1	6.39	0.60	0.54	1.75	1.58	0.148	0.147	3320	3740
3	4963	6.4	6.15	0.52	0.55	1.67	2.00	0.151	0.174	3083	3757
3	4964	5.8	6.25	0.54	0.56	1.71	1.83	0.134	0.162	4160	3527
3	4965	4.5	6.39	0.63	0.77	2.08	1.75	0.164	0.153	3217	3827
3	Wamego Quartzite	19.0	6.18	0.62	0.67	1.83	1.83	0.110	0.143	3237	3063
3	5156	9.8	6.27	0.49	0.49	1.79	1.79	0.138	0.129	3500	3600
3	5158	8.4	6.13	0.55	0.56	1.58	1.58	0.131	0.140	4250	3465
3	Frey Limestone	7.8	6.08	0.63	0.59	1.83	1.75	0.185	0.164	2927	2193
3	Stadium Limestone	2.6	6.37	——	——	1.83	1.83	0.230	0.195	3060	3673

TABLE 2

DATA ON CONCRETE IN WHICH LINCOLN COUNTY, KANSAS, SANDSTONES OF VARYING FRENCH CO-EFFICIENTS WERE USED AS AGGREGATES

No. of Specimens	No.	French Co-efficient	Fineness Modulus of Mixed Aggregate	Water-Cement Ratio Cem. 3	Water-Cement Ratio Cem. 4	Slump in In. Cem. 3	Slump in In. Cem. 4	Inches of Wear Cem. 3	Inches of Wear Cem. 4	Compressive Strength, Lbs. per Sq. In. Cem. 1	Compressive Strength, Lbs. per Sq. In. Cem. 2
						SERIES 2					
3	1	9.2	6.20	0.62	—	1.75	—	0.095	—	3930	—
3	4	8.1	6.11	—	0.65	—	1.54	—	0.092	—	3787
3	2	12.9	6.12	—	0.60	—	1.50	—	0.890	—	3640
3	3	12.5	—	0.63	0.67	1.73	1.42	0.118	0.101	3443	3407
3	5	12.8	6.11	0.65	—	1.42	—	0.095	—	3715	—
3	6	2.5	6.10	—	0.70	—	1.79	—	0.146	—	3240
3	7	14.0	5.06	0.62	0.61	1.58	1.59	0.122	0.108	3273	2978
3	8	13.3	6.39	0.65	0.60	1.83	1.54	0.101	0.104	4013	3703

after the tests were completed. This was true especially of those made from concrete having a water-cement ratio of 1.2. The coarse aggregate was torn from the mortar in several cases. This is illustrated in Fig. 3. The sphere made from concrete having a water-cement ratio of 0.7 is smooth while the one made from the concrete having a water-cement ratio of 1.2 is very rough.

The data on the concrete for the first series of tests is shown in Tables 1 and 2. The water-cement ratios in this series were variable and the strengths obtained did not correspond with them.

It was evident from the experience gained in these tests that the method of calculating the amount of water absorbed by the stone and deducting it from the total to get the amount used in the concrete was unreliable and had a tendency to give water-cement ratios which were unreasonably low. It was observed in the preceding series that when stones such as quartzite having a low absorption were used, less water was necessary to produce the desired consistency and that after the concrete was mixed, it could be placed in the mold readily without getting dry and stiff. It was also observed that the standard slump test was not entirely satisfactory as a measure of consistency because of the tendency of the coarse aggregate to arch and give low slumps.

With these facts in mind, it was decided to overcome the absorption of the coarse aggregate in all of the remaining tests by soaking the stone in water for from one to three hours and surface drying. One per cent by weight was allowed for the absorption of the sand. Since concrete having a definite strength was desired, the weight of water to be used was calculated by means of the water-cement ratio and kept constant throughout the tests. The slump test was made and the value recorded. The relative flow was measured and recorded. No attempt was made to keep these values constant. However, if in the judgment of the operator, the workability of the mix changed, an investigation was made as to the cause of the change. It was usually found that a change had taken place in the gradation of the fine aggregate. All the concrete was mixed in the 28- by 28- by 4-in. pans with trowels. Twelve spheres and four cylinders were made from each aggregate in order to get better average results. The data on the concrete for this series is shown in Table 3.

TABLE 3

DATA ON CONCRETE IN WHICH KANSAS STONES OF VARYING FRENCH CO-EFFICIENTS WERE USED AS COARSE AGGREGATE

Number	French Co-efficient of Coarse Aggregate	No. of Specimens	Water-Cement Ratio	Slump in In.	Relative Flow	Barrels of Cement per Cu. Yd. of Concrete	Wear in In.	Compressive Strength, Lbs. per Sq. In.
				SERIES 3				
A	5.2	12	0.7	2.54	118	1.50	0.147	3806
B	17.3	12	0.7	2.50	125	1.54	0.119	3710
C	2.3	12	0.7	3.10	151	1.58	0.114	3760
D	7.3	12	0.7	2.60	163	1.53	0.145	3750
E	9.1	12	0.7	2.65	138	1.61	0.125	3900

The data obtained from the last series of tests in which the French Co-efficient of the coarse aggregate was the variable were very satisfactory. The strength of the concrete at 28 days was slightly above Abrams' average strength curve. The maximum wear in inches for the series was 0.147.

This was for the specimens in which a local coarse aggregate having a French Co-efficient of 5.2 was used. The minimum was 0.114 in. for the loosely cemented sandstone having a French Co-efficient of 2.3 from Holliday, Kansas. The wear for the specimens in which limestone having a French Co-efficient of 7.3 was used was 0.145 in. and of 9.1 was 0.125 in. It is significant that the concrete made from stone having the lowest French Co-efficient of wear had the highest resistance to abrasion and that the difference of the wear in inches for the concretes having variable coarse aggregates was very slight. The wear in inches and the strength are plotted against the French Co-efficient in Fig. 4. The wear in inches per hundred revolutions is shown in Fig. 5.

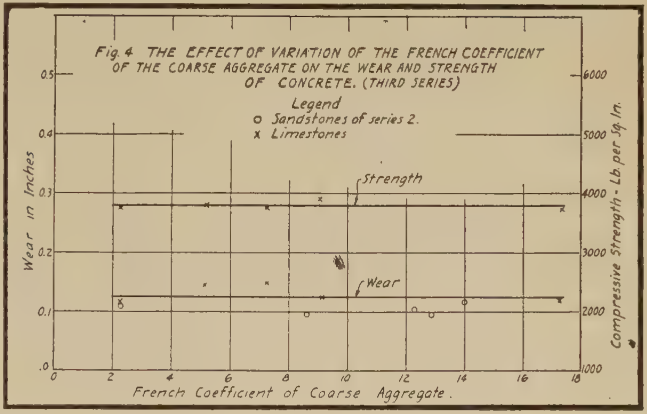


Figure 4

The strength of all the specimens in series 3 was uniform. The data show that the strength of the concrete is not a function of the French Co-efficient of the coarse aggregate. The value of the slump and the flow for the whole series show considerable variation but since the resulting strengths are uniform and a constant amount of water was used throughout, the observation that these methods of measuring consistency are not reliable seems to be correct.

Three brands of cement were used in the study of the

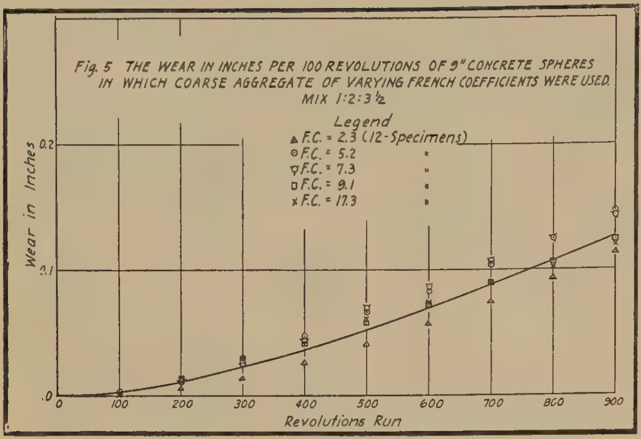


Figure 5

effect of magnesium and zinc fluosilicate surface hardener on the wearing quality of concrete in order to determine whether or not all cements reacted in the same way to the treatment. The coarse and fine aggregates and all other conditions were kept constant. The specimens were all air-cured and the resulting loss of resistance to abrasion due to lack of curing moisture in the first 28 days is apparent. The wear for the series of untreated specimens varies from 0.540 in. for cement 2 to 0.473 in. for cement 4 as compared with 0.147 in., the maximum in the preceding series. This brings out the importance of proper curing conditions for concrete. A considerable variation in the resistance to wear of concrete made from different brands of cement was found. The wear in inches per hundred revolutions is shown graphically in Fig. 6.

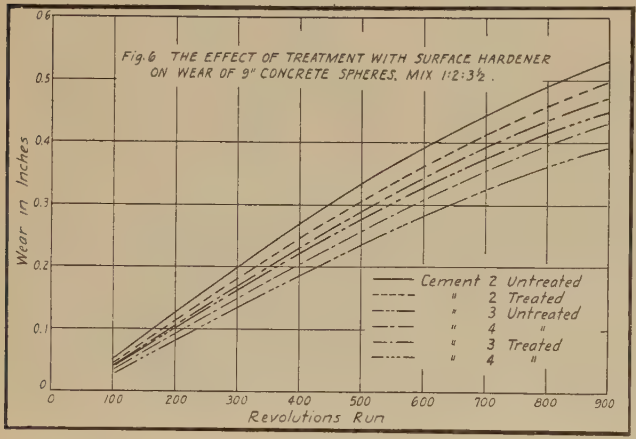


Figure 6

TABLE 4
DATA ON CONCRETE OF VARYING WATER CONTENT

No. of Speci-mens	Water-Cement Ratio	Slump in In.	Relative Flow	Barrels of Cement per Cu. Yd. of Concrete	Wear in. In.	Compressive Strength at 28 Days, Lbs. per Sq. In.
6	0.6	0	100	1.51	0.133	3350
6	0.7	1.75	112	1.54	0.135	3496
6	0.8	5.79	175	1.52	0.193	2593
6	0.9	*	*	1.50	0.260	1973
6	1.0	*	*	1.51	0.290	1755
6	1.1	*	*	1.49	0.348	1325
6	1.2	*	*	1.49	0.561	1202

*Slump was as great as size of coarse aggregate would permit.

In studying the effect of variable water content on the resistance to wear, the only variable in making the specimens was the ratio of the volume of the water used to the volume of the cement. This ratio was varied from 0.6 to 1.2 by 0.1 increments. The data for the concrete for this series of tests is shown in Table 4. The average wear in inches per hundred revolutions is shown graphically in Fig. 7. The decrease in resistance to wear was about constant for each increase in the water-cement ratio between the ratios 0.7 and 1.1. The wear in inches of the specimens in which water ratios of 0.6 and 0.7 were used were about the same. The maximum wear in inches for the 0.6 specimens was 0.133 and for the 0.7 was 0.135. It is evident that the decrease of the water-cement ratio below 0.7 does not produce a concrete with higher resistance to abrasion. The increase of the wear in inches for the increase in the water-cement ratio is gradual until the 1.1 is passed. The specimens in which a ratio of 1.2 was used show a wear in inches of 0.561 as compared with 0.348 for the ratio of 1.1 or an increase of 0.213 in.

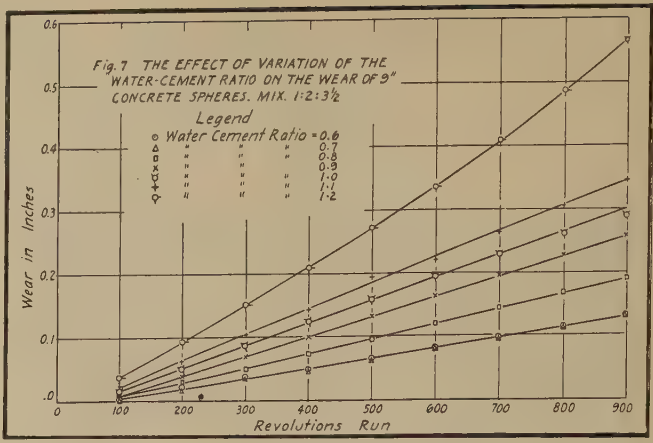


Figure 7

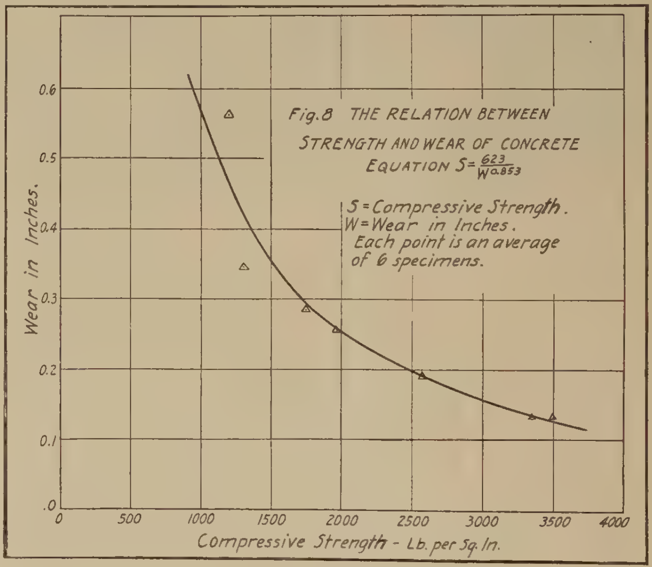


Figure 8

The equation for the relation of wear and compressive strengths of concrete was worked out by the method of averages and was found to be of the general form $S = \frac{K}{W^a}$ in which S is the strength in pounds per square inch, W is wear in inches, K and a (an exponent) are constants, the values of which depend upon the form of test used, the age, the quality of the cement, the gradation of the coarse and fine aggregate, the proportions or mix used

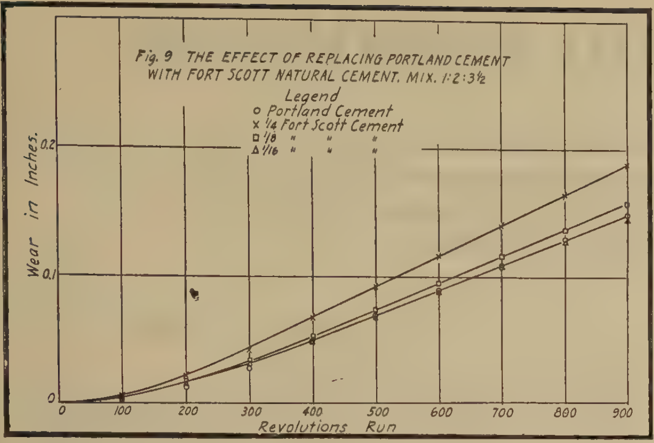


Figure 9

and the conditions of curing of the specimens. The equation of the curve of Fig. 8 was found to be $S = \frac{623}{W^{0.353}}$.

Substitution of Natural Cement

Three sets of specimens were made in which a part of the portland was replaced with Fort Scott hydraulic cement. On the first set, 25 per cent of the portland by volume was replaced by Fort Scott. In the second and third, 12½ per cent and 6¼ per cent respectively. The wear in inches per hundred revolutions is shown graphically in Fig. 9.

The maximum wear for the straight portland was 0.151 in., for the 25 per cent natural cement was 0.189 in., for the 12½ per cent was 0.158 in. and for the 6¼ per cent Fort Scott was 0.145 in. The replacement of 25 per cent of the portland cement with natural cement reduced the resistance to wear of the concrete 25 per cent. The replacement of 12½ per cent of the portland cement with natural cement reduced the resistance to wear only 5 per cent. The replacement of 6¼ per cent of the portland cement with natural cement did not reduce the resistance to wear.

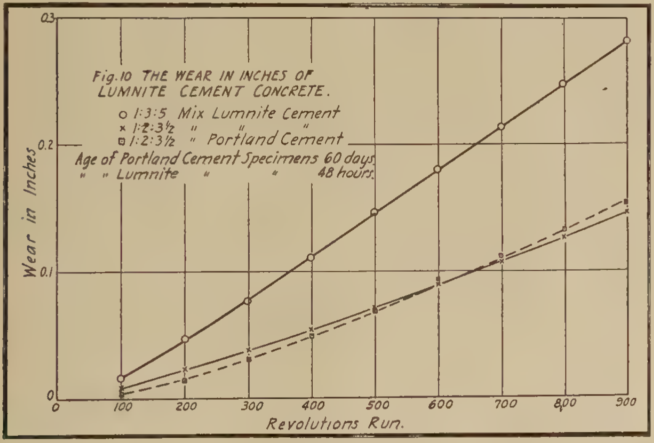


Figure 10

Strength and wear tests were made on specimens made from Lumnite cement. 1:2:3½ and 1:3:5 mixes were used and comparisons were made with portland cement concrete strength at the age of 28 days and wear at the age of 60 days. The wear in inches per hundred revolutions is shown graphically in Fig. 10. The maximum wear in inches for the 1:3:5 Lumnite was 0.278 in. and for the 1:2:3½ was 0.143 as against 0.151 for the portland cement. The wear of the 1:2:3½ specimens of Lumnite and portland almost coincide throughout the 900 revolutions. The wear on the specimens of the 1:3:5 mix was higher from the first hundred revolutions. The increase in the wear became greater as the test progressed.

Conclusions

The following conclusions are justified by this series of tests:

1. That the testing of three 9-in. spheres of 60-day concrete in a paving brick rattler with a standard abrasive charge is a satisfactory and convenient method of measuring the resistance to abrasion.
2. That the French Co-efficient of the coarse aggregate does not materially affect the resistance to wear or the strength of portland cement concrete of a 1:2:3½ mix by dry loose volume; that is, good results may be obtained by the use of any coarse aggregate which is structurally sound.
3. That different brands of cement produce concretes of different wearing quality.
4. That the use of a surface hardener will increase the resistance to wear of all concrete but will affect some brands of cement more than others.
5. That proper curing is absolutely necessary to produce concrete which will have a high resistance to wear.
6. That the use of an excessive amount of mixing water will reduce the resistance to wear of concrete in about the same proportion as it will reduce the strength.
7. That the relation of the wear and strength of concrete is expressed by the equation $S = \frac{K}{W^a}$ in which S = compressive strength in pounds per square inch, W = wear in inches and K and a (an exponent) are constants.
8. That the replacement of 12½ per cent or more of the volume of the portland cement with Fort Scott hydraulic cement in a 1:2:3½ mix by dry and loose volumes will reduce the strength of the concrete and the resistance to wear in proportion to the amount of portland cement replaced.
9. That Lumnite cement concrete of the same proportions as portland cement concrete will have the same resistance to wear at 48 hours that the portland will have at 60 days.

Ohio Bridge

The concrete in this bridge spanning the Shade river at Chester, Ohio, seems to be as good as this view is pleasant to look upon. The structure replaces a 64-year-old wooden, covered bridge. The dam powers the water mill to the right.

Concrete Floors in Residences

Advantages of Concrete Floors in Dwelling Houses—How Concrete Floors Can Be Finished—Placing Floor Coverings—Treating the Floor Itself—A New Service in Concrete Floor Construction—Cost —An Opportunity for Products Manufacturers

TEN years ago, concrete floors in residences were practically unheard of, except those in very expensive homes. Little was known about their design and cost, so architects, as well as contractors and home builders, hesitated about using them. They admitted their ability to resist wear and their structural value, but these advantages were outweighed by preconceived ideas of hardness and unattractiveness. Their objections were probably based on comparisons with sidewalks and basement floors.

One of the main objections to concrete floors was their excessive cost, due in a large measure to the contractor's inexperience and lack of knowledge as to their construction. Realizing this situation, a prominent engineering company, having offices in 15 of the larger cities, has made a study of this problem and has found a practical solution. It is offering a service that will relieve both the architect and the contractor of the problems which heretofore have been a handicap in the construction of concrete floors.

This company takes the dimensions furnished by the architect, designs the floor, erects column, beam and floor forms, furnishes and places the reinforcement, and even calculates the amount of concrete needed. All the contractor has to do is furnish the concrete and place it. The type of concrete floor built by this company is known as ribbed floor construction and one engineer in each of their offices devotes his entire time to concrete residence floors, co-operating with architects and engineers.

Methods of Finishing Concrete Floors

Other objections to concrete floors were that they were hard and unattractive. One must remember that practically all the floors in hotels, clubs, apartments, office buildings, and hospitals are of concrete. The average home owner, who thinks concrete floors are undesirable, must have forgotten the comfort, convenience and luxury that the patrons of these places have enjoyed. It is true that some of these floors may have had some covering over the reinforced concrete slab but these same materials can be used in residence floors.

A concrete tile floor in residential use

This covering can be a hardwood floor of maple, birch, beech or oak, which is nailed to wooden strips, embedded in the concrete, or secured with floor clips, so embedded. This practice is common in living and dining rooms, where a wood surface is desired. Floors laid in this manner will not sag, creak or warp.

The surface of this concrete floor has been marked off, colored and polished to resemble tiling. Such a floor is easily cleaned and polished

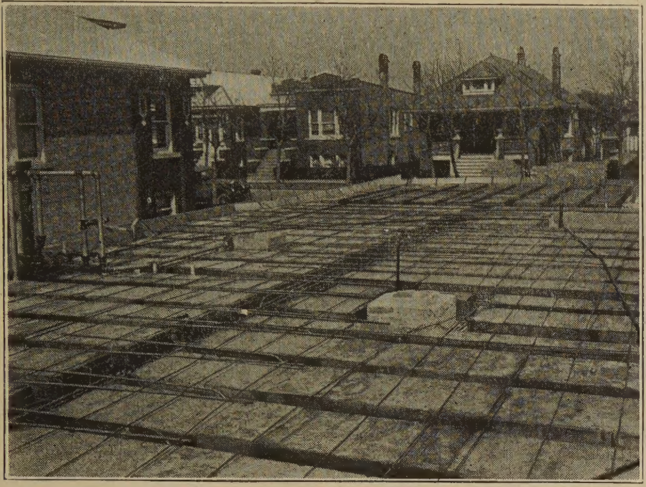
Where a resilient surface is desired, plain, inlaid, jaspe or embossed linoleum or rubber flooring—either in sheets or as tile—may be used. This type is used in hallways and kitchens mostly. Cork tile or cork flooring may be used in the same way. Coverings of these types are cemented or pasted direct to the concrete, and if applied according to the manufacturers' specifications, they will not bulge or pull loose.

If a hard surface is desired—concrete tile, terrazzo, the ceramics, mosaics, slate or art marble, are cemented to the concrete base. Such freedom in design and color is possible with these materials, that they are not merely a supplement, but often dominate the beauty of the interior design. Ceramic tiles are obtainable in many colors and are used in hallways, sun parlors and dining rooms. Concrete tile is frequently used in living rooms. While these types are by no means confined to such usage, their general use is in entrance halls and sun parlors.

A type of finish that is gaining in favor is the treatment of the concrete slab itself. Such a floor is the most economical and several methods are employed to develop beauty and character. Mineral pigments, stains and chemicals are used to produce color, while oiling, waxing and polishing give the surface desired. The surface is often marked off into squares, or other patterns, to resemble tiling. A concrete floor is impervious to moisture and therefore can be easily cleaned and polished.

Cost Is Low

As mentioned before, concrete floors have been associated more or less with the more expensive homes, but this is no longer true. The cost has been reduced to a price that the average home owner can afford to pay. The engineering service previously mentioned interferes in no way with the plans of the architect or the builder, but on the other hand, assists them. This company specializes in this line of work, and its experienced engineers and trained erecting crews, assure the architect and builder of a first class concrete floor. This cost has been made possible through the use of this company's own products—and the fact that its equipment is used time and time again. When a job is finished, a crew removes the steel forms and the same equipment is moved to the next job.



Metal forms in place ready for concrete

Just a word about cost. The rate in Omaha and in St. Louis for this service is 35 cents per square foot for first floors up to 2,000 sq. ft. in area, and it is likely that approximately the same rate exists where this company has offices. About one-third of a cubic foot of concrete is required per square foot of floor area, which costs about 15 cents, bringing the total cost to approximately 50 cents per square foot, which is only about 20 cents per square foot more than for average wood construction. For a moderate size residence the additional cost for a firesafe floor will be only $150.

Here is an opportunity for concrete products manufacturers to extend their activities by placing the concrete for the residence floor at the same time they are supplying the block or tile for the walls or foundations.

Painting of Plasters and Cements Discussed

At a joint meeting of the Incorporated Institute of British Decorators and the Oil and Colour Chemists Association in London recently, a joint discussion on the painting of plasters and cements took place.

W. E. Greenwood, a decorator, spoke of the great need for some central organization to which a decorator could apply for information as to the nature of the materials which could be placed upon cement and plaster surfaces. Such a body should be able to state the chemical composition of the paint that could safely be used, according to the nature of the surface to be covered. he said.

A. D. Cowper, of the Building Research station, gave a brief account of the chemical composition of the common types of plastering materials from the point of view of the application of paint to them, adding that the ordinary text books are often misleading in this respect. The use of an alkaline plaster always meant trouble, from the painting point of view, for months, and in the chemical composition of plasters one should always look out for lime. A written guarantee from the maker of a plaster was the only safeguard, he said.

Moisture and Alkali

S. A. Bone, a paint manufacturer, said that if the basic principles associated with the painting of cements and plasters were better understood, there would be fewer failures. The two great enemies of the painter on walls were moisture and alkali. Paints of an oily character would not adhere on wet plaster and the plaster must be dry. Mr. Bone said he did not think that tung oil in combination with a pigment could be used to kill the lime. Tung oil would not kill lime, but it could be used, and was used, to resist the effect of alkali and formed a very important ingredient in most alkali-resistant primers and undercoats. In the case where walls were definitely known to be alkaline, one of the best preliminary treatments was a solution of zinc sulphate.

Haste in Drying

T. Wilson, superintendent of works, Houses of Parliament, said that much of the trouble today in painting plaster surfaces was due to the fact that so little time was allowed for them to dry. What the chemists would have to do in this matter would be to find a material that would be as fluid as oil paint and have a permanence which could be guaranteed. Painters and decorators had experimented empirically and had obtained some very interesting results, which, however, needed verification by the chemists. He therefore suggested that the chemists should take this matter boldly in hand, and lay it down with a certain amount of dogmatism that there were certain things which could be used. They should clear the ground of oil paint and attempt to find something of a different nature, as, for instance, a product which had recently come on to the market, and which he had experimented with in regard to fresco work, viz., a silicon ester. There were great possibilities for this, although at present it was in its tentative stages.

Chemical Painting

Dr. J. J. Fox, of the government laboratory, said his advice in regard to painting plaster walls was to give the walls plenty of time to dry before painting. Unless that were done, the painters were asking the paint manufacturers to provide something which was impossible. With a lime plaster, the lime remained free under the surface for a considerable period. Zinc sulphates, if carefully used, would neutralize the lime by forming zinc oxide and calcium sulphate. There was another way of dealing with the matter which had not been used to any great extent, and that was, after a period of say two years from the building of the wall, to give it a coat of a solution of zinc silicofluoride or magnesium silicofluoride, materials which were on the market under proprietary names. That would be as effective, probably, as zinc sulphate. As a chemist, he could see another way altogether. When the colloid chemists really got to work in paint manufacture, they ought to be able to produce a water emulsion containing sufficient waterproofing material and pigment colors to go straight on even to a wet plaster.—*Chemical Age.*

Mixer Musings

Reported by "Joe"—The Mixer Boss.

DEAR Joe:

For darn near thirty years concrete has been my breakfast food. It makes no difference what kind of a concrete job it is, I've done it. And that goes, regardless. All these new fangled hoity toity ideas about concrete are old stuff for me. I'm for 'em—with reservations.

But when one of these rah rah boys who's got so darn much brains that he's got to hide them behind a lot of smart talk gets onto one of my jobs, then something's goin' to come or break. But sometimes these guys fool you.

Here is what I mean. On one of my bridge jobs there was a sweet young feller—the son of one of the railroad stockholders, I guess—come out to be the inspector.

"It is not true, Mr. Cohen" he says to me, (My name is S. Cohen. Stands for slump cone) "that hydration has an effect in dispersing the cement granules to colloidal dimensions, but because insoluble crystalline or amorphous substances comprise the bulk of the concrete material, this fact has only a limited effect on the workability of the resulting concrete?"

"Horsefeathers!" says Old Jim, who has been my foreman all these years.

"Well," says I kind of cautious like, "maybe not. Old Jim here has one of these here psychoses. Don't pay too much attention to his remarks. He gets to raving like that once in a while. But there is something to what you say. It's important if it's got anything worth while in it about workability."

"Exactly, Mr. Cohen," he comes back. "That is the subject under discussion. Now, since you can't depend to any very great extent on lubricating the mass with the limited facilities in the concrete as you make it now, it is imperative that we cast about for another more efficacious means of securing this desired result."

Old Jim stands there with an expression on his face that comes only when he is under great emotional strain. But I'm not so sure that this is all hoy. Maybe this egg does know what he's talking about.

"Well, what of it?" says I.

"Just this," says that walking dictionary, "visual examination has convinced me that you are having an inordinate amount of difficulty in placing your concrete. My first remark, or observation, as you prefer, indicates the fallacy of seeking a remedy for this unfortunate condition at that point. Let us, therefore, shift our attention to some of the other elements involved. Our ratio of cement to water is irrevocably fixed by the specifications. But what of the size and grading of the aggregates? Here we have an infinity of latitude, and, inasmuch as exhaustive research has demonstrated the fact that varying proportions require varying amounts of water to secure workability, it is barely possible that we may be able, by diligent application of this fundamental principle, to find here some means of alleviating the situation."

Well, it's a long story. But that crazy egg, hiding behind his horn rimmed glasses, was able to get up a new mix for us that saved us a bunch of jack.

Yours truly,
(Signed) S. Cohen.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

Twenty-fifth annual convention, Book-Cadillac hotel, Detroit, Mich., Feb. 12th to 14th.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

1929 convention and road show, Cleveland, Ohio, Jan. 14th to 19th.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; Wharton Clay, Commissioner, 123 W. Madison St., Chicago.

Association of Cast Stone Manufacturers; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Products Association; F. O. Matthiessen, Secretary, 641 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Fall Meeting, Buckwood Inn, Shawnee on Delaware, Pa., Oct. 1st to 3rd.

Iowa Concrete Products Association; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. W. Dickson, Executive Secretary, 2226 Builders Building, Chicago, Ill.

National Association of Builders' Exchanges; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 E. Twenty-second St., New York City.

The National Lime Association; J. L. Durnell, Chairman, Executive Committee, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

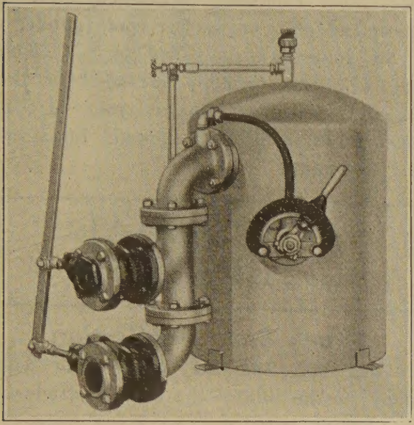
Rail Steel Bar Association; H. P. Bigler, Engineering Secretary Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 3115 Plankinton Arcade, Milwaukee, Wisconsin.

New Equipment and Materials

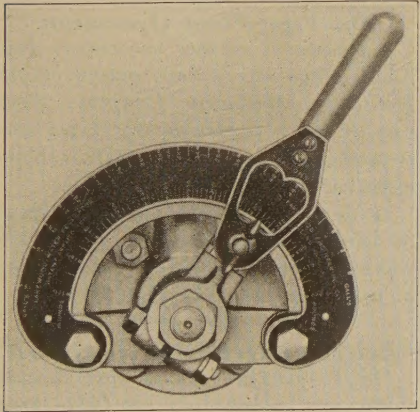
New Water Regulator Shows Gallons and Pounds

With the accurate control of the mix reaching the point in development that it has at the present time, manufacturers are giving thought to the equipment needs of the industry and numerous helpful devices are being born.



One of these aids is the Lakewood water regulator shown. This combined water tank and measuring device allows, according to the manufacturer, quick setting and changes in the water-cement ratio and quick allowance for the moisture contained in the aggregate of the mix. Absolute accuracy of discharge, batch after batch, for any given setting is claimed.

The upper part of the scale is in gallons, to conform to the water-cement ratio, and the lower scale is in pounds. A double pointer is provided on the lever so that a given setting of the tank can be read simultaneously in gallons and pounds. Assuming, as an example, that the mix requires 48 gallons of water and compensation is necessary for 40 pounds of moisture in the sand, the lever is set at 48 on the upper scale and then moved back 40 pounds on the lower scale to 360 pounds.



The manufacturer places particular emphasis on the simplicity of design, including the lack of complicated internal parts.

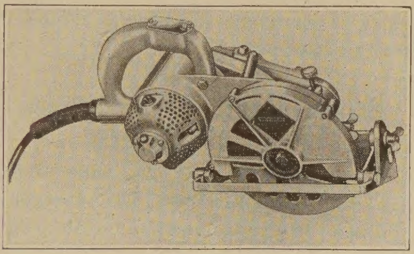
The Lakewood Engineering Company, Cleveland, Ohio, is the manufacturer.

New Small Handsaw Has Lower Cutting Guard

The most noteworthy features of a new small electric Alta handsaw, are the safety guard, ruggedness of design, and adaptability to a variety of work. Cutting capacity is 2 in.

The lower guard, said to be an exclusive patented feature, which encloses the saw blade, opens gradually by telescoping into the upper guard as the saw is pushed into the material, and immediately snaps shut as the cut is finished.

It is built in three models; one for plain square cutting; one for bevel cutting, (shown in the illustration), and one with adjustable dado cutter for grooving. On all three models, the shoe is adjustable vertically, making it possible to set the saw to cut any required depth.



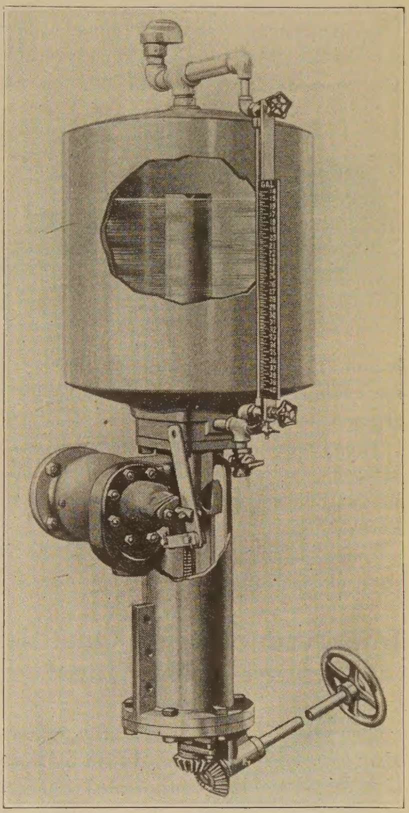
A high-speed universal motor, fan-cooled, mounted on ball bearings, furnishes the power and shoots a blast of air to the front of the saw, thus clearing the sawdust away and making it possible to follow a line accurately. The saw shaft, mounted on tapered roller bearings, is driven by helical gears which are mounted on ball bearings, all completely enclosed and running in grease. A double-pole non-arc switch is mounted in the handle within easy reach of the operator's forefinger. The frame is all aluminum, highly polished, and all exposed steel parts are rustproofed. Various parts are made of heat-treated aluminum alloy to retain lightness and obtain maximum strength and durability.

A handy steel saw table, size 16 in. by 26 in. by 11 in. high can be furnished, to which the saw may be attached.

The Wappat Gear Works, Inc., Pittsburgh, Pa., are the manufacturers.

New Smith Water Tank for Water Cement Ratio

The water measuring tank shown in the accompanying illustration has been designed with the object of securing absolute accuracy down to an ounce. It is claimed also that the accuracy of the tank is unaffected with the paver operating on a side or up or downhill slope—said to be one of the most prominent causes of inaccuracy in water tanks. The design follows the practice of manufacturers of pumps used in measuring liquids for sale as in gasoline filling stations.



Recent exhaustive tests by the highway department of a state prominent in concrete road building are said to have indicated unusually fast emptying and have borne out the claims for accuracy unaffected by slope.

The amount of water discharged is varied by raising or lowering a central pipe of large diameter. A convenient hand wheel on the operator's platform permits of regulation to the ounce. The tank and valve are self-cleaning and the regulating parts are non-rusting.

The new tank has been furnished on Smith 27-E pavers shipped during the current year.

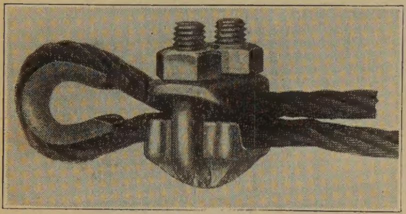
New Equipment and Materials

New Cable Clip Has Triple Grip

A cable clip with a considerable large holding surface has been put into production, in a full range of sizes, by the Eureka Metal Products Corporation of North East, Pa.

It is a patented clip which, according to tests, is said to have shown its ability to carry three times the maximum load of an ordinary clip and give equally good results both on wire rope and messenger strand.

Besides giving a larger holding surface, the Eureka clip is designed to save cable. The large surfaces of both the top and bottom plates are grooved for the lay of the cable, so that neither of the cables is gripped by the U-bolt.

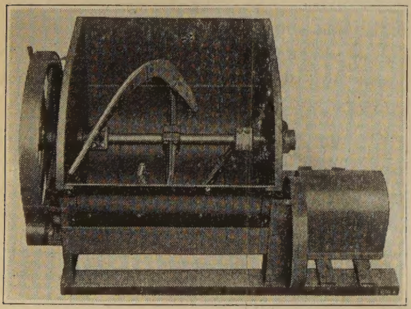


The clip has only four parts and its extra grooved jaw is peened to the "U." Any size wrench can be used to tighten up the Eureka clip.

These patented clips are made in all sizes, of steel or bronze.

Improved Wearing Qualities Feature of New Ideal Mixer

The advent of a new concrete products plant batch mixer under the Ideal brand is heralded by the Consolidated Concrete Machinery Corporation, Adrian, Mich., in literature pointing out its exclusive features. Five of the foremost improvements are a shorter and deeper drum, larger, quick-opening and tight-locking door, choice of paddles, or spiral blade protected by Strenes metal wearing plates, extra protection for wearing parts, and lastly, chain, Tex-rope or gear for motor drive.



In line with laboratory and field experiments that have shown a short, deep drum to result in better mixing than one long and shallow, the drum depth increases more in proportion than the length, in the sizes from 9 ft. up. The drum heads, it is noted, are semi-steel, cast integral with leg and bearings. Renewable Strenes metal plates protect the spiral blade.

The extra large discharge door swings on links. A hand lever opens the door, reverse motion closes it, and toggles assure its being kept closed, the manufacturer points out.

One of the protections of wearing parts is the Strenes metal plates in the drum heads. These plates are designed to divert the wear to the spring collars on the shaft. Another instance is the round, full strength shaft, of cold rolled steel. The arms supporting the blade or the paddles are clamped to the shaft at milled seats where they are fit snugly to prevent longitudinal as well as radial movement.

The Strenes metal liner, which is available as extra equipment, is placed inside the drum in order to take the grinding wear of the concrete being scraped around by the paddles. It is furnished with a two-year guarantee involving a refund of the purchase price.

Super Porto Saw Design Aims at Safety

The manufacturer of the Super Porto saw, the Portable Power Tool Company, Chicago, Ill., calls attention to 16 points featured by the saw.

The first of these is the clear vision blower, permitting the following of pencil line markings at all times. The second is the top safety guard, insuring complete coverage and protection without clumsiness. Another is the beveling device, making possible exact bevel cuts to any angle from 0 to 45 deg. inclusive, it is claimed.

Another feature is the easily gripped front handle, of swivel jointed design conforming to the operator's natural hand and arm position. The depth gauge also is said to be a new type, quickly adjustable, but rigid and firm when set. The cooling and cleaning fan is mounted on a shaft in front of the motor and is claimed to be dynamically balanced and efficient in keeping the motor cool and clean.

Butler Address

The address of the Butler Bin Company was erroneously given as Pittsburgh, Pa., in a short item on this page in the August issue describing the new telescoping material bin manufactured by the firm. It should have read, instead, Waukesha, Wisconsin.

Notes from the Field

New Sales Manager

Paul Johnson has resigned from his position as sales manager of the *Construction Machinery Company*, Waterloo, Iowa, to accept an offer not as yet made public.

Mr. Johnson is succeeded by *R. C. Weller*, who was formerly president of the Marsh-Capron Company and prior to that sales manager of the Lakewood Engineering Company.

INDUSTRIAL LITERATURE

Truck Body Publication

"Wet Mix and the Wood Bath Tub Body" is the title of the feature article in the August issue of *"The Wood Hoister,"* a monthly, 4-page publication of interest to the user of truck bodies and hoists, published by the Wood Hydraulic Hoist & Body Co., Detroit, Mich. It concerns the mounting of the "bath-tub" type wet mix body on a light high-speed chassis, supplementing a June article on the delivery of wet mix concrete.

Other short items are of equal interest.

Saw Blade Folder

The Portable Power Tool Corporation, Chicago, Ill., has published a small folder entitled "How to Select the Right Blades," referring to cutting equipment for its Super Porto electric saw.

On Pipe Plant Operation

A species of catalog too seldom published is that very recently put out by the *McCracken Machinery Company*, Sioux City, Iowa. It is rare in that 5 per cent is catalog and 95 per cent deals with the operation of pipe plants.

Much worth-while reading matter seems to have been put into this publication, which is said to be the only catalog type of publication distributed by the firm.

"Better Concrete—at Less Cost"

"Better Concrete—at Less Cost," a small folder just published by the *Celite Products Company*, has chapters covering the securing of workable concrete and telling how Celite is added. One page is devoted to the water-cement ratio, telling of the effect of Celite upon the former, and another page gives results of tests made to determine the water-tightness of concrete.